Attachment A

Requirements for Connection of Small Distributed Energy Resource Facilities to the Local Distribution Company's Distribution System

25 kW and Below (Residential/Small Commercial) Single Phase Application

Requirements for Connection of Small Distributed Energy Resource (DER)
Facilities to an LDC's Distribution System
25 kW and Below (Residential/Small Commercial)
Single Phase Application
May 2000

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1.0 INTRODUCTION

The advent of new and emerging technologies, the need for prudent energy conservation and management, and the concern for the environment and other issues have contributed to the development of alternate energy resources. Restructuring of the utility industry to provide for competition and customer choice have resulted in significant growth in Distributed Energy Resource (DER) applications. As a result, the following guidelines are provided for uniform and consistent application within the LDC's system. These guidelines are intended to assure proper interconnection and protection to LDC equipment, employees, customers and the general public when a customer operates electrical generation equipment in parallel with the LDC's distribution system. These guidelines, among other issues, also cover (1) customer design requirements and operating procedures and (2) LDC design requirements and operating procedures. A companion document (Part B) covers the requirements for three-phase and larger size DER interconnections to the LDC's distribution system. "Customer" and "DER owner" terminology will be used interchangeably throughout these guidelines.

2.0 DESCRIPTION OF LDC's DISTRIBUTION SYSTEM

Most LDC's distribution systems are either in a radial or network configuration. The radial configuration is one which serves customers from a single-phase or three-phase, radial source. In general, this system is a three-phase multi-grounded wye system, energized at either 4.16, 12.47, 13.2 or 34.5 kV phase-to-phase. However, in very limited cases, the distribution system may be connected in a delta configuration and as such may require special protection for ground faults. This requirement may be limited to DER systems that could back-feed during an outage of the LDC supply source. Approximately 75% of the radial distribution lines are single-phase and operate at 2.4, 7.2, 7.6, or 19.9 kV. Typically, the small, single-phase DERs are supplied at secondary voltages of 120/240 volts.

If the LDC's primary or secondary system has an automatic load transfer system between two different circuits or sources, then the interconnection request will have to be reviewed closely by the LDC to ensure proper protection and coordination between the customer DER facility and the multiple circuits/sources.

A secondary network, such as an LDC may have in urban downtown areas, consists of a system of interconnected cables, usually energized at 208 volts or 480 volts phase-to-phase, supplied from a number of primary circuits and station transformers. Due to the inherent electrical characteristics of network systems, DERs cannot be easily accommodated on a secondary network system. Case-by-case review is required to evaluate the feasibility of a customer DER connection to the LDC's network systems.

3.0 DESCRIPTION OF DISTRIBUTED ENERGY RESOURCE

A customer can use a variety of energy sources in a distributed energy resource project, such as fossil, hydro, bio-mass, gas, wind or solar energy to generate electrical energy. In the case of an application involving direct current (dc) such as solar and wind and energy storage technologies, electrical energy can be delivered to the LDC's system through the use of a DC to AC inverter[1].

The electrical interconnection between the customer and the LDC's distribution system establishes a parallel system that connects the customer's generation to a common bus[2], and allows the transfer of electrical energy into the LDC's distribution system. The electrical energy, generated in parallel[3] with the LDC's system, must have a sinusoidal 60 Hz alternating current wave form without the impact of harmonics and with voltage regulated within normal LDC limits of ±5%, and frequency of ±0.5hz.

4.0 CUSTOMER DESIGN REQUIREMENTS

For an interconnection to be safe to LDC employees / equipment and to other customers, the following conditions are required to be met on customer-owned DER equipment.

4.1 Customer DER facilities must meet all applicable national, state, and local construction, operation and maintenance related safety codes, such as National Electric Code (NEC), National Electric Safety code (NESC), Occupational Safety and Health Administration (OSHA), etc.

4.2 Customer DER must provide the LDC with a one-line diagram showing the configuration of the proposed DER system, including the protection and controls, disconnection devices, etc. The DER owner is responsible for installing appropriate equipment and facilities so that the generation is compatible with the LDC's distribution system.

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[1] An inverter is an electronic device which converts direct current to alternating current.

[2] Bus is normally referred to the secondary side of station transformer which forms the beginning of the distribution feeder system.

[3] Parallel implies that the company, and customer DER system are connected together at a common node, typically at the energy metering point or Point of Common Coupling (PCC).

4.3 Customer DER must be equipped with adequate protection to trip[4] the unit off line during abnormal[5] system conditions, according to the following guidelines:

4.3.1 Induction Generator or Line-Commutated Inverter Interface Undervoltage, typically minus 10% with a base voltage of 120 volts or equivalent service delivery voltage.

4.3.2 Synchronous Generator or Self-Commutated Inverter Interface

4.3.2.1 Undervoltage or overvoltage, typically plus or minus 10% with a base voltage of 120 volts or equivalent service delivery voltage.

4.3.2.2 Underfrequency or overfrequency, typically plus 0.5 Hz or minus 0.5 Hz at a 60 Hertz base frequency, for small distributed resource systems 10 kW and smaller; When the utility frequency is outside the range of nominal frequency (+.5/-0.5 Hz for small systems $\leq$ 10kW), the DER shall be constructed to cease to energize the EPS within 15 Cycles. By agreement of both the DER operator and the EPS operator, different settings maybe used for the under frequency and over frequency trip levels or time delays.

4.4 Customer DER requires the following additional protection to avoid possible damage to the customer's DER equipment and LDC's system during normal, as well as abnormal system conditions.

4.4.1 Synchronizing controls to insure a safe interconnection with the LDC's distribution system. The DER must be capable of interconnection with minimum voltage and current disturbances. Synchronous generator installations, as well as other types of installations, must meet the following: slip frequency less than 0.1 Hz, voltage deviation less than $\pm$ 10%, phase angle deviation less than $\pm$ 10 degrees, breaker closure time compensation (not needed for automatic synchronizer that can control machine speed).

4.4.2 A disconnect switch to isolate the DER for purposes of safety during maintenance and during emergency conditions. The LDC will require a disconnect device provided, installed by, and paid for by the customer, which

[4] To trip is to open the appropriate breaker to deenergize the voltage source.

[5] Abnormal system conditions include faults due to adverse weather conditions including but not limited to, floods, lightning, vandalism, and other acts that are not under the control of the LDC. This may also result from improper design and operation of customer facilities resulting from non-compliance with accepted industry practices.

is accessible to and lockable by Company personnel, either at the primary voltage level, which may include load-break cutouts, switches and elbows, or on the secondary voltage level, which may include a secondary breaker or switch. The switch must be clearly labeled as a DER disconnect switch.

4.5 Customer equipment must have adequate fault interruption and withstand capacity, and adequate continuous current and voltage rating to operate properly[6] with the LDC's present and planned future system.

4.6 When inverter systems are intended to be used as the DER, they should be pre-tested, approved and listed by Underwriter's Laboratories or similar independent testing laboratories for harmonics and other specification issues such as frequency operating range and current-distortion levels. Customer must provide DER test data to the LDC, in order to facilitate the LDC approval process.

4.7 The DER owner can facilitate the LDC approval process for the DER interconnection by assuring that the DER interconnection equipment meets LDC pre-certification requirements. Conformance tests shall be performed by a manufacturer to confirm that the interconnection system design meets requirements. Factory tests shall be performed by a manufacturer in the factory before equipment is shipped. These tests should cover the testing of DC Current Injection, overvoltage protection, undervoltage protection, overfrequency protection, underfrequency protection, current unbalance, surge withstand capability, fast transient testing, islanding detection, dielectric testing, etc. This list is not all inclusive.

4.8 Harmonics and Flicker: The DER owner shall take responsibility for limiting harmonic voltage and current distortion and/or voltage flicker[7] caused by its generation equipment. Limits for harmonic distortion (including inductive telephone influence factors) are consistent with those published in the latest issues of ANSI/IEEE 519, "Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems." LDC criteria requires that flicker occurring at the point of compliance shall remain below the Border Line of Visibility curve on the IEEE/GE curve for fluctuations less than 1 per second or greater than 10 per second. However, in the range of 1 to 10 fluctuations per second, voltage flicker shall remain below 0.4%. Refer to Appendix C, Exhibit 1. Depending upon the nature of the generation and its location, the LDC may require the installation of a monitoring system to permit

[6] Properly, in this context, means within the acceptable utility or applicable industry established practices.
[7] Flicker is an objectionable, low frequency, voltage fluctuation which can be observed through changes in intensity or color of illumination.

ongoing assessment of compliance with these criteria. The monitoring system, if required, will be installed at the DER owner's expense. Situations where high harmonic voltages and/or currents originate from the distribution system are to be addressed in the Connection Agreement.

4.9 DC Injection from inverters shall be maintained at or below 0.5% per inverter.

4.10 Customer generation must operate and maintain voltage within normal LDC limits of ±5% of 120 volts or equivalent service delivery voltage.

4.11 System Grounding: The DER system should be grounded in accordance with applicable codes. A ground fault sensing scheme will be required by the DER customer when he uses a wye-delta connected transformer as part of the DER connection to the LDC's system. This ground fault scheme will protect the customer's equipment from system ground faults that may occur in his system, or in the system to which the customer is connected. Information relating to grounding of photovoltaic (PV) systems as required by the NEC can be found in "Photovoltaic Power Systems and the National Electrical Code: Suggested Practices, SAND96-2797, Sandia National Laboratories, 1996.

4.12 The LDC reserves the right to charge the customer a fee for LDC review of drawings and diagrams of customer-owned DER equipment and for LDC field check of equipment to verify compliance with design requirements.

4.13 The customer must notify the LDC in the event of a change in the design, size, or technology for the DER before final plans are implemented.

5.0 CUSTOMER OPERATING PROCEDURES

5.1 The customer should maintain voltage at the interconnection point, under steady state operating conditions, within LDC limits of ± 5% of nominal on the 120 volts base.

5.2 If high-voltage, low-voltage, or voltage flicker complaints arise from other customers due to the operation of customer DER, the customer may be required to disconnect his or her generation equipment from the LDC's system until the problem has been resolved.

5.3 Customer generation must not produce harmonic currents or voltages that will interfere with the LDC's metering accuracy and/or proper operation of facilities and/or with other customer loads. Such adverse effects may include, but are not limited to heating of wiring and equipment, overvoltage, communication interference, etc.

5.4 When a primary line fault occurs on the LDC's distribution circuit, the DER customer must detect and trip off-line in 60 cycles (one second) or less, thus clearing and not sustaining a fault on the LDC's system.

5.5 Proper steps should be taken to prevent unintentional islanding[8].

5.6 The customer should not reconnect DER to the LDC's system after a trip from a system protection device, until the LDC's system is re-energized for a minimum of five minutes. If the customer were to connect a backup generator, in the event to serve a critical load, he must open his main breaker or utilize a transfer switch prior to generator hook up, in order to ensure no back feed into the LDC's distribution system. This is a critical safety requirement.

5.7 The customer must discontinue parallel operation when requested by the LDC, so that maintenance and/or repairs can be performed on the LDC's facilities.

5.8 The customer will be responsible for damage caused to other customers and/or to the LDC, due to a malfunction, improper design, misoperation or human error of the customer's DER or controls.

5.9 The customer must notify the LDC in the event that the DER is removed from service on a permanent basis.

5.10 Please refer to section 7.2 for additional responsibilities.

6.0 LDC PROTECTION REQUIREMENTS

6.1 Typically, distribution system fault protection is provided at the station recloser or breaker to clear temporary and/or permanent faults that may occur on the distribution system, due to lightning, tree contacts, animals, vehicle accidents and equipment failures. In areas where full protection coverage cannot be maintained by the station recloser or breaker, line reclosers and fuses (often single phase devices) are used to provide protection. These devices protect sections or branches of the system and clear faults on the system when faults occur. For proper operation of the system, the protective devices in series will need to be coordinated for prompt clearing of the fault, and for avoidance of unnecessary operation of multiple protective devices. Accordingly, it is important for the LDC and customer protective devices to coordinate properly for safe and timely isolation of the faulted system or faulted equipment.

[8] Unintentional island—an unplanned condition where one or more DERs and a portion of the electric utility grid remain energized through the point of interconnection.

6.2 Transformer Requirements for DER applications: A dedicated transformer is required to mitigate harmonics and other abnormal conditions which may occur with other customers in the adjacent area, as a result of the DER installation

6.2.1 **New customer with DER**: A dedicated transformer is required. The customer is responsible for the total costs associated with the installation of a dedicated transformer.

6.2.2 **Existing customer-Dedicated transformer- planning to install DER**: If this customer is the only customer served from an existing transformer, there is no cost to the customer, since the transformer already exists.

6.2.3 **Existing customer planning to install DER**: If the existing transformer serves other customers in addition to this customer, then a separate transformer dedicated to the DER customer would be required. The customer is responsible for the total costs associated with the installation of a dedicated transformer.

Exception: Exception to this requirement may be made, where the customer provides documentation through independent laboratory tests or certification that the generator system harmonics are within industry standards/guidelines. After installation, if the harmonics injection causes adverse impact on the LDC or other customers, a dedicated transformer or filtering will be required.

6.3 Although the customer provides the required protection devices, as specified in section 4.3, the LDC will not rely solely upon the customer's protection devices to prevent the transfer of energy into the distribution system during abnormal conditions, or when maintenance and/or repairs are being performed on the LDC's system.

6.3.1 A manual disconnect device is required to be installed on all DER systems. This disconnect device should be accessible and lockable by LDC personnel. It may be a secondary breaker or switch. The switch must be clearly labeled as a DER disconnect switch. Cost, installation, and maintenance of the switch is the responsibility of the customer.

7.0 LDC OPERATING PROCEDURES FOR ITS EMPLOYEES OR CONTRACTORS

7.1 The transfer of electrical energy from the customer-owned DER into the LDC's distribution system is possible, depending on the type of DER. Therefore, LDC employees must strictly adhere to LDC safety rules, covered in the LDC's

Safety Manual, and/or other applicable articles. Exhibit I includes examples of sections from a LDC (Sections E.1.03 and E.4.02, respectively).

In following these rules, the LDC will advise the customer to disconnect and isolate all customer DER facilities from the LDC's system during abnormal conditions, such as system outages, emergencies and equipment maintenance. Furthermore, the LDC will advise the customer to disconnect all DER generation which affects the LDC's ability to control, maintain, and provide quality of service to other customers without any detrimental reduction in system frequency, voltage regulation, power factor or detrimental increase in harmonic distortion. These requirements are spelled out in the terms and conditions of the LDC's tariffs.

The LDC may install special tags at all transformer and/or isolating pole locations, interconnected with customer DER facilities, to warn LDC field personnel that a customer-owned energy source exists. LDC circuit maps and diagrams used by LDC operators or field personnel must include the location of customer-owned generation and isolating devices/disconnect switch. Additional design requirements and/or safety controls or procedures could be required in the future.

Exhibit I

*Excerpts from an LDC's Safety Manual

E 1. General Precautions

1.03 All circuits and equipment shall be considered energized at full voltage until de-energized and grounded or where grounding is impractical, other precautions are taken to insure there is no possible energy source, including lightning, induced voltage or customer-owned generation facilities.

E 4. Working on De-energized Lines or Equipment

4.02 When taking lines or equipment requiring a Dispatcher's or Operator's clearance out of service, it shall first be de-energized by an appropriate switching device, such as disconnect, interrupter, circuit breaker, fuse or recloser. For work on equipment, isolating disconnecting switches on both sides of the equipment shall be opened. For work on lines, the line shall be disconnected from the electric circuit by a visible disconnecting means (except for totally enclosed units) and any other possible sources of energy including customer-owned generating facilities, and checked open. For totally enclosed units such as SF6, alternative methods for determining disconnection shall be used. Lines and equipment taken out of service shall be properly tagged.

*Reference: Information from March 30, 1998 revision of AEP Safety Manual

7.2 Disconnection and reconnection. The LDC may disconnect a DER from the LDC's distribution system under the following conditions:

7.2.1 Expiration or termination of interconnection agreement. The interconnection agreement specifies the effective term and termination rights of the LDC and customer. Upon expiration or termination of the interconnection agreement with a customer, in accordance with the terms of the agreement, the LDC may disconnect customer's facilities.

7.2.2 Non-compliance with the technical requirements specified in this document . The LDC may disconnect a distributed energy resource if the facility is not in compliance with the technical requirements specified in this document. Within two business days from the time the customer notifies the LDC that the facility has been restored to compliance with the technical requirements of this document, the LDC shall have an inspector verify such compliance. Upon such verification, the customer in coordination with the LDC may reconnect the facility.

7.2.3 System emergency. The LDC may temporarily disconnect a customer's facility without prior written notice in cases where continued interconnection will endanger persons or property. (Verbal notice will be provided.) During the forced outage of the LDC's system, the LDC shall have the right to temporarily disconnect a customer's facility to make immediate repairs on the LDC's system. When possible, the LDC shall provide the customer with reasonable notice and reconnect the customer as quickly as reasonably practical.

*7.2.*4 Routine maintenance, repairs, and modifications. The LDC may disconnect a customer or customer DER with seven business days prior written notice of a service interruption for routine maintenance, repairs, and system modifications. The LDC shall reconnect the customer as quickly as reasonably possible following any such service interruption.

8.0 METERING

The DER Owner shall be responsible for the installation and operating costs of the bi-directional metering equipment at the delivery point. The metering equipment may include voltage and current transformers where necessary. The accuracy of the instrument transformers will be 0.3 percent or better accuracy class for revenue metering. The overall accuracy of the metering will comply with established Public Service Commission guidelines for tariff metering. The metering equipment will be tested periodically as defined in the connection agreement and the test results will be available

to all involved parties. The meters, test switches and wiring termination equipment shall be sealed by LDC personnel.

At least (N-1) metering elements will be used to measure all power crossing the metering point, where N is the number of wires in service including the ground wire. Bi-directional watt-hour energy flow, and where required var-hour energy flow, will be registered separately. Depending on the tariffs to be applied, appropriate demand quantities will be metered in terms of kilowatt, kilovars or kilovolt-amperes.

9.0 CUSTOMER APPLICATION, DATA / OTHER REQUIREMENTS

The customer should submit an application to the LDC requesting the proposed DER interconnection to the LDC's distribution system. The LDC will respond within 4 weeks of the customer application for pre-certified DER units, and within 6 weeks for requests not involving pre-certified DER equipment.

The customer may be required to pay a non-refundable fee for the study that would be required due to the interconnection. In addition, there may be local facilities cost associated with the improvements necessary to interconnect the DER according to the guidelines established in this report. Refer to Appendix A for required customer data.

APPENDIX A

NOTIFICATION OF INTENT TO INSTALL AND OPERATE DER INTERCONNECTED WITH A LDC DISTRIBUTION SYSTEM

Title	NOTIFICATION OF INTENT TO INSTALL AND OPERATE DISTRIBUTED ENERGY RESOURCE INTERCONNECTED WITH THE LOCAL DISTRIBUTION COMPANY 'S (LDC) DISTRIBUTION SYSTEM	Page: 1 of 4 Revision: Date: 5/18/2000

PURPOSE: The information to be provided in this Notification of Intent to Install and Operate a Distributed Energy Resource (DER) is necessary to evaluate and successfully integrate the DER facility within an LDC distribution system and to provide for compatible operation of the integrated facilities. Failure to comply with the LDC's Tariffs and Regulations filed with the Federal and State agencies having jurisdiction in the LDC's operating area may result in discontinuation of service or refusal to furnish service to the DER.

FILING: Any DER owner who plans to install generation that will be connected to the interconnected elements of an electric service supplied from the LDC's distribution system is to complete this form and submit it to a LDC Customer Service representative. Any subsequent change in the information supplied by the DER owner on this document is to be communicated to the LDC Customer Service representative by the DER owner as soon as available.

NON-REFUNDABLE FEE/OTHER COSTS: The DER owner is required to pay a nonrefundable fee according to established fee schedule. Refer to document entitled "Distributed Generation Interconnection Study Non-refundable Fee Structure." The DER owner shall reimburse the LDC for all costs incurred by the LDC for facilities and services required to review, evaluate and provide for operation of the **Owner's** generation, including, but not limited to, the evaluation of information provided in this document. Following the project completion, customer-written notification of the project termination, or other interval as determined by the LDC, an accounting of the charges due the LDC less the non-refundable fee will be submitted to the DER owner.

1.0 OWNER INFORMATION

Entity/Requester/Company Name: _____
Facility Owner's Name: _____
Mailing Address: _____
City: _____ County: _____ State: _____ Zip Code: _____

2.0 PROJECT DESIGN/ENGINEERING INFORMATION

Company: _____
Mailing Address: _____
City: _____ County: _____ State: _____ Zip Code: _____
Contact Representative: _____ Phone No. _____

3.0 FACILITY INFORMATION

3.1 Expected Date of installation:_____

3.2 Interconnection voltage level_____volts

3.3 Does the **Owner** propose to export power to the LDC distribution system?
_____ Yes _____ No
If yes, indicate the proposed contract type to be made with the LDC:
(a) Proposed Contract Capacity in kW to LDC _____
(b) Proposed Yearly kWh Sales to LDC _____
(c) Indicate Sales Schedule _____ kW On-Peak _____ kW Off-Peak
_____ kWh On-Peak _____ kWh Off-Peak

3.4 How many DER generating units does the owner propose to operate? _____
Specify the proposed operating date for each unit: _____ _____
_____ _____ _____ _____ _____

4.0 ESTIMATED OPERATIONAL INFORMATION: This information will be used to properly determine the capacity interfacing requirements for the **Owner's** proposed DER facility, and establish maintenance, supplementary, and backup power requirements.

4.1 DER Operating Hours/Year: _____

4.2 The DER System will operate in the following mode:
- Base Load On-Peak Only
- Base Load 24 Hours a Day
- Peak Shaving
- Emergency/Maintenance Only
- Supplemental

4.3 Energy Generated kWH or MWH/Year: _____

4.4 Min. and Max. Anticipated Facility Load with DER not Operating:
Minimum - _____ kW _____ kVA Maximum - _____ kW _____ kVA

4.5 Min. and Max. Anticipated Facility Load with DER Operating:
Minimum - _____ kW _____ kVA Maximum - _____ kW _____ kVA

4.6 Specify the contract capacity desired:
_____ kW _____ kVA

NOTE: Specified Supplementary Capacity plus Specified Backup Capacity must equal the Specified Contract Capacity.

5.0 DER EQUIPMENT INFORMATION

The following data is to be provided for each DER generating unit. Additional copies may be submitted for multiple units.

5.1 Energy Resource Data

Manufacturer (if available): _____

Model: _____

Type: ✎ Synchronous ✎ Induction ✎ Inverter

Frequency (Hz): _____

Rated Output: _____ kW _____ kVA

Rated Power Factor (%): _____ Rated Voltage (Volts): _____

Rated Amperes: _____

5.2 Prime Mover

Manufacturer (if available): _____

Model: _____

Rated Horsepower: _____ Maximum Horsepower: _____

Type:

- ❑ Steam Turbine
- ❑ Fuel cell
- ❑ Combustion Turbine
- ❑ Induction
- ❑ Synchronous
- ❑ Wind
- ❑ Battery
- ❑ Other (Specify): _____

ENERGY Source: ✎ Coal ✎ Oil ✎ Gas

- ❑ Off-peak utility
- ✎ Renewable (Specify) _____
- ✎ Other (Specify) _____

6.0 ATTACHMENTS OWNER TO PROVIDE WITH THIS DOCUMENT

6.1 A summary, signed by the **Owner** management, that provides a general description of the intended manner or operation for the DER facility.

6.2 Three copies of drawings and specifications prepared and approved by a registered professional engineer adequately detailing the facility location and proposed location of the **Owner's** DER facilities with respect to the **Owner's** desired point of electric service and the appropriate disconnecting devices.

6.3 Three copies of a comprehensive single-line diagram prepared and approved by a registered professional engineer. This information must comprehensively show the **Owner's** intended configuration for operation including switching devices, transformers, generation facility, protective devices, metering devices, capacitors, proposed conductor sizes, etc.

7.0 OWNER AUTHORIZATION: I, the undersigned and authorized representative of the above DER facility, acknowledge that the aforementioned information is to be used for a review process performed by the LDC who will subsequently provide appropriate engineering and operational comments and/or concerns that must be addressed and jointly resolved with the LDC.

Owner permission to operate generation in parallel with the LDC will only be granted after specified LDC requirements and contractual commitments are met. I also acknowledge receipt from a LDC Customer Service Representative of a document titled "Requirements for Connection of Small Distributed Energy Resource Facilities to an LDC's Distribution System."

Authorized Signature: _____ Date: _____

Name (Print): _____ Title: _____

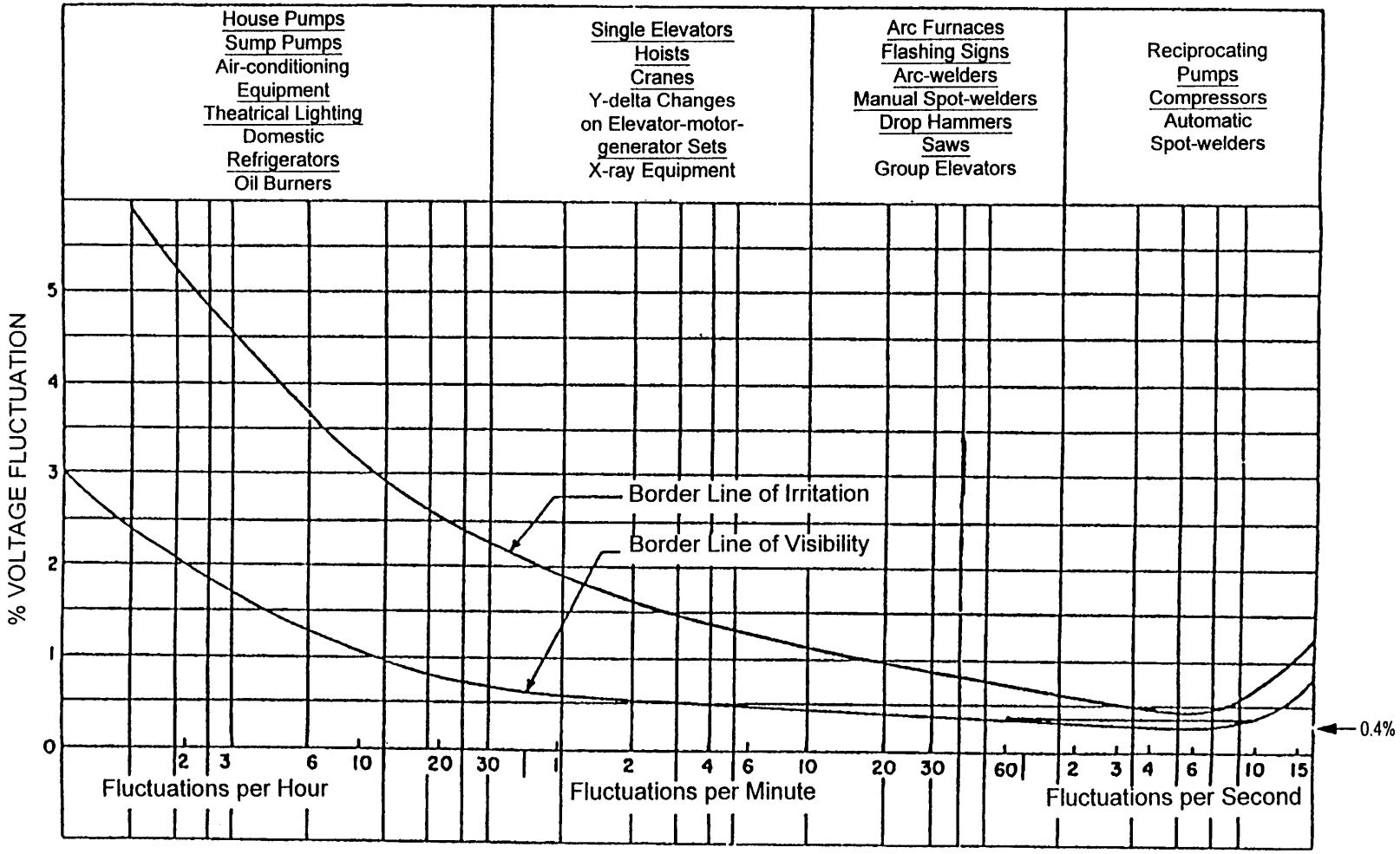
APPENDIX B

Figure 1—Distributed Energy Resource Interconnection to LDC’s Distribution System

APPENDIX C

Exhibit 1—Relations of Voltage Fluctuations to Frequency of Their Occurrence

Exhibit 1



Composite curve of voltage flicker studies by General Electric Company, *General Electric Review*, August 1925; Kansas City Power & Light Company, *Electrical World*, May 19, 1934; T&D Committee, EEI, October 24, 1934, Chicago; Detroit Edison Company; West Pennsylvania Power Company; Public Service Company of Northern Illinois.

Relations of Voltage Fluctuations to Frequency of Their Occurrence (Incandescent Lamps)

Attachment B

Requirements for Connection of Distributed Energy Resource Facilities to the Local Distribution Company's Distribution System
Three-Phase Application

Requirements for Connection of Distributed Energy Resource (DER)
Facilities to a LDC Distribution System
Three Phase Application
May 2000

Table of Contents

1.0 INTRODUCTION

Although this document is comprehensive and elaborate in its requirements for safe interconnection of Distributed Energy Resources (DER) to a LDC's distribution system, the requirements may vary depending on the size, technology, location, distribution system configuration, and other factors. Refer to section 17.0.

1.1 Background: The advent of new and emerging technologies, the need for prudent energy conservation and management, and the concern for the environment and other issues have contributed to the development of alternate energy resources. Restructuring of the utility industry to provide for competition and customer choice have resulted in significant growth in Distributed Energy Resource (DER) applications. As a result, the following guidelines are provided for uniform and consistent application within the LDC system. These guidelines are intended to assure proper interconnection and protection to LDC equipment, employees, customers and the general public when a customer operates electrical generation equipment in parallel with the LDC's distribution system. These guidelines, among other issues, also cover (1) customer design requirements and operating procedures and (2) LDC design requirements and operating procedures. A companion document (Part A) will cover the requirements for single-phase DER interconnection to LDC distribution systems. Please note that the terminology 'customer' and 'DER owner' will be used interchangeably throughout these guidelines.

1.2 Scope: This document informs entities seeking parallel operation of DER with a LDC distribution system of its'connection requirements. The requirements are applicable to all facilities connecting to the LDC distribution system, both those owned by the LDC as well as facilities owned by other parties.

The minimum requirements pertaining to connected facilities are contained herein. Reliability concerns in particular are such that additional requirements may need to be imposed on connecting facilities based on their location within the system, facility power level and the associated impacts on the LDC's system performance. The need for additional requirements can only be evaluated once certain details of a proposed facility are made known and system impact studies have been conducted.

The requirements for initial facility connection apply equally to continued operation of existing connected facilities. Therefore, any upgrades, additions, enhancements, or changes of any kind to an existing connected facility are subject to LDC review to ensure continued compliance with these requirements.

The scope of these documents is limited to the technical requirements for connected facility design and operation. It should also be noted that certain studies such as system dynamics/stability studies are normally required for larger size DERs.

1.3 Objectives: This document is based on the following objectives:

1.3.1 Maintain system reliability, personnel and equipment safety, and quality of service as new facilities are added to the LDC's distribution system and existing facilities are modified.

1.3.2 Ensure comparability in the requirements imposed upon the various entities seeking to connect facilities to the LDC's distribution system.

1.3.3 Inform those entities that seek parallel operation of DER (interconnection) with the LDC distribution system of the various requirements for system reliability, safety of personnel and equipment and quality of service.

1.3.4 Facilitate uniform and compatible equipment specification, design, engineering, and installation practices to promote safety and uniformity of service.

1.4 Facility Connection Study

A facility connection study is performed to evaluate and determine the physical connection between the LDC's distribution system and a proposed DER. The electrical configuration of the connection equipment including transformers, switchgear and other station equipment, and required distribution line sections are determined. Appendix A illustrates some of the more typical configurations for facility connections, but other possibilities exist depending on the particular situation. The physical layout of equipment and right-of-way needs are determined in the DER interconnection study as well. Typically, more than one alternative is considered in developing a DER interconnection, depending upon the accessibility of the local area distribution facilities and the needs of the proposed connected facility. A multi-step approach may be considered in the facility connection study to accommodate a multi-step increase in generation for the connected facility. Normally, the expense of developing the DER interconnection is the responsibility of the DER owner.

1.5 System Impact Studies

In order to assess the impact of proposed DER interconnection on system reliability and protection, system impact studies need to be conducted. These system impact studies, as a minimum, examine the distribution line and transformer loading; voltage profiles and schedules; minimum reactive requirements; and power quality impacts of the proposed facility for a range of expected seasonal loading and power transfer conditions. The effect of the proposed facility on short circuit duties is examined for all proposed DER facilities and distribution connections. Stability performance is also assessed for proposed DER facilities depending on the size. A multi-step approach to the proposed facility may be considered where the impact of each step is assessed separately. Alternative plans of service may be considered.

1.5.1 Power Flow Analyses

Power flow analyses are conducted to examine the impact of the proposed facility on nearby distribution line and transformer loading, and nearby voltage profiles. These analyses may typically determine the maximum generation that can be accommodated with minimal or no upgrades to the distribution system. Contingencies consisting of single or multiple outages of lines and/or transformers are considered in these analyses. Where the analyses indicate that distribution upgrades are necessary, alternative reinforcement plans may be devised and evaluated for their capability to accommodate the proposed facility. These analyses may also indicate a need to perform dynamic studies for larger size DERs.

1.5.2 Short Circuit Analyses

Short circuit analyses are conducted to examine the impact of the proposed facility on equipment duties. Increased fault duties may require upgrading existing circuit breakers and other equipment.

1.5.3 Transient Stability Studies

The ability of a proposed DER facility to remain in synchronism with the LDC's distribution system during disturbances, including faults, is investigated here. As with load flow analyses, transient stability studies determine how much generation can be accommodated at a given location. Typically, disturbances corresponding to the contingencies examined in the load flow analyses are simulated. Other aspects of system dynamic performance affected by the proposed generation facility may be assessed. Any required remedial measures, distribution facility upgrades and/or additional design requirements for the proposed DER facility are identified.

1.5.4 Additional Analyses

Other analyses may be required as part of system impact studies depending on the nature of the proposed connected facility and its location within the distribution system. Power quality analyses are undertaken for all generation that could potentially cause harmonic current or voltage, voltage flicker, and/or telephone interference. Criteria for harmonic interference, voltage flicker, and telephone interference are included in the document appendices.

The scope of all the above system impact studies is determined by the LDC based on the type, location, and power level of the proposed facility. Normally, the LDC will perform the system impact studies at the expense of the **Owner**.[1] A

[1] Hereinafter the Owner refers to the Distributed Energy Resource owner or third party acting on behalf of the DER owner. The word 'customer' may also mean DER owner. The words 'customer', 'DER owner', and 'owner' are used interchangeably in this document.

report documenting the assumptions, results, and conclusions of the system impact studies is made available to the DER owner.

The LDC must be notified of new facilities, upgrades, or additions such as an increase in load or added DER units to existing facilities connected to the distribution system within the LDC service area. System impact studies are to be conducted to determine the need for any upgrades of distribution equipment or distribution reinforcements to the LDC's distribution system to accommodate the changes in the connected facility.

1.6 Initiating a Facility Connection or Facility Change

The following table outlines the LDC personnel to be contacted with regard to any request for a new facility connection significant change to an existing connected facility. Requests for distribution service may be made simultaneously with a connection request. The DER owner is required to complete and forward a 'Notification of Intent to Install and Operate a DER' to the LDC contact with the appropriate fee and all necessary attachments (Refer to Appendices B and E). The table below summarized the interface needed with the LDC by the entities seeking to connect their DER facilities to the LDC's distribution system.

Type of Facility To be connected	Service or Activity Required from LDC	LDC Contact
Distributed Energy Resource (Generation)	Initial Contact to Request Connection or Studies	Customer Service Dept.(small commercial applications) Or Customer Operations Dept (residential applications)

Following the initial contact regarding a proposed DER facility connection, when the DER's proposed location and power level are established, a plan of service is prepared and system impact studies are undertaken by the LDC. The information needed to develop a plan of service and to conduct the system impact studies is identified in this document and should be provided to the LDC at this point. The system impact studies may, as noted above, identify additional requirements for reliability beyond the minimum requirements covered by this document.

LDC approval of a proposed facility or facility change is contingent upon a design review of the proposed connected facility. Operation of a connected facility is also subject to continuing compliance with all applicable construction, maintenance, testing, protection, monitoring, and documentation requirements described herein.

2.0 DESCRIPTION OF LDC's DISTRIBUTION SYSTEM

The LDC's distribution system is either a radial or a network configuration. The radial configuration is one which serves customers from a single-phase or three-phase, radial source. In general, this system is a three-phase multi-grounded wye system, energized at either 4.16, 12.47, 13.2 or 34.5 kV phase-to-phase. However, in very limited cases, the distribution system may be connected in a delta configuration and as such may require special protection for ground

faults. This protection requirement may be limited to DER systems that could back-feed during an outage of the LDC supply. A significant portion of the radial distribution lines are single-phase and operate at 2.4, 7.2, 7.6, or 19.9 kV.

If the LDC's primary or secondary system has an automatic load transfer system between two different feeders or sources, then the interconnection may have to be reviewed closely to ensure proper protection and coordination between the customer DER facility and the multiple circuits/sources.

The secondary network, such as a LDC may have in urban or downtown areas, consists of a system of interconnected cables, usually energized at 208V or 480 V phase-to-phase, and supplied from a number of primary circuits and station transformers. The great majority of the secondary network is connected at 208/120V or 480/277V; however, other possible voltage levels exist for possible interconnection. Due to the inherent electrical characteristics of network systems, DERs cannot be easily accommodated on a secondary network system. Case-by-case review is required to evaluate the feasibility of a customer DER connection to LDC's network systems.

3.0 DESCRIPTION OF DISTRIBUTED ENERGY RESOURCE

A customer can use a variety of energy sources in a DER project, such as fossil, hydro, bio-mass, gas, wind or solar energy to generate electrical energy. In the case of applications involving alternating current (ac), the system's electrical energy can be delivered to the LDC's system through the use of synchronous or induction generators. In the case of applications involving direct current (dc) and energy storage technologies, electrical energy can be delivered to the LDC's system through the use of a DC to AC inverter[1].

The physical connection between the customer's electrical system and the LDC's system establishes a parallel[2] system that connects the customer's generation to a common bus[3], and allows the transfer of electrical energy into the LDC's distribution system. The electrical energy, generated in parallel with the LDC's system, must have a sinusoidal 60 Hz , undistorted alternating current wave form with voltage regulated within normal LDC limits of $\pm$5%, and frequency of $\pm$0.5hz.

4.0 TYPES OF CONNECTED CIRCUIT CONFIGURATIONS

The typical arrangements for DER connection to distribution lines are shown in Appendix A, figures 1 through 5. These figures illustrate some examples of acceptable configurations for connection of DERs to the LDC distribution system. These diagrams could vary depending on the type of protection system required, the distribution source (delta or wye connected), and other configurations.

[1] An inverter is an electronic device which converts direct current to alternating current.

[2] Parallel means that the LDC and customer DER system are connected together at a common electrical node or point, typically at the energy metering point or Point of Common Coupling (PCC).

[3] In this context, Bus is normally referred to as the point of connection with the LDC's distribution system either at primary or secondary voltage.

5.0 CUSTOMER DESIGN REQUIREMENTS

For an interconnection to be safe to LDC employees/equipment and to other customers, the following conditions are required for customer-owned DER equipment.

In addition, the Company may, at its option, perform final review and inspection of the customer DER system installation prior to commissioning of its facility.

5.1 Customer DER facilities must meet all applicable national, state, and local construction, operation and maintenance related safety codes, such as National Electric Code (NEC), National Electric Safety Code (NESC), Occupational Safety and Health Administration (OSHA), etc.

5.2 Customer DER must provide the LDC with a one-line diagram showing the configuration of proposed DER system. The DER owner is responsible for installing appropriate equipment and facilities so that the DER is compatible with the LDC distribution system.

5.3 The minimum LDC distribution system connection requirements for the DER are as follows:

5.3.1 Generator Frequency: The DER owner's facility will provide a balanced, symmetrical, three phase interchange of electrical power with the LDC distribution system at a nominal frequency of 60 Hz $\pm$ 0.5Hz.

5.3.2 System Protection: The DER owner is responsible for providing adequate protection to LDC facilities for conditions arising from the operation of generation under all LDC distribution system operating conditions. The owner is also responsible for providing adequate protection to their facility under any LDC distribution system operating condition whether or not their DER is in operation. Conditions may include but are not limited to:

1. Loss of a single phase of supply,
2. Distribution system faults,
3. Equipment failures,
4. Abnormal voltage or frequency,
5. Lightning and switching surges,
6. Excessive harmonic voltages,
7. Excessive negative sequence voltages,
8. Separation from supply,
9. Synchronizing generation,
10. Re-synchronizing the Owner's generation after electric restoration of the supply.

More complete relaying system requirements are identified later in this section.

5.3.3 Interrupting Device: All DER owners shall provide a three-phase circuit interrupting device with appropriate relaying systems to isolate the DER facilities from the LDC supply for all faults, loss of LDC supply, or abnormal operating conditions regardless of whether or not the owner's DER is in operation.

This device shall be capable of interrupting the maximum available fault current at that location. The three-phase device shall interrupt all three phases simultaneously. The tripping control of the circuit interrupting device shall be powered independently of the utility AC source in order to permit operation upon loss of the LDC distribution system connection.

The specific reclosing times for the DER owner's circuit interrupting device will be provided by the LDC. It is the DER owner's responsibility to design and maintain their interrupting device(s) to properly isolate generation upon loss of the LDC connection until the appropriate LDC facilities are returned to service.

5.3.4 System Grounding: The DER system should be grounded in accordance with applicable codes. A ground fault sensing scheme will be required by the DER customer when he uses a wye-delta connected transformer as part of the DER connection to the LDC's system. This ground fault scheme will protect the customer's equipment from system ground faults that may occur in his system, or in the LDC system to which the customer is connected. Information relating to grounding of photovoltaic (PV) systems as required by the NEC can be found in "Photovoltaic Power Systems and the National Electrical Code: Suggested Practices, SAND96-2797, Sandia National Laboratories, 1996.

5.3.5 Voice Communication Circuit: The DER owner may be required to establish a dedicated voice communication circuit to the LDC system control center to permit coordination of the synchronization and operation of the generation, depending on the DER's capacity (kW).

5.3.6 Disconnecting Devices: A three phase air break switch or a three-pole single-throw disconnect switch shall be installed on each distribution line supply entrance to the Owner's facility to be accessible at all times. The disconnecting device shall be mechanically lockable in the open position with a LDC lock in order to provide for a visible electric isolation of the Owner's facility and shall be identified with a LDC designated equipment number. The disconnect switch is required to isolate the DER for the purposes of safety during maintenance and during emergency conditions. The device must be clearly labeled as a DER interrupting device.

5.3.7 Disturbance Monitoring: The DER owner's system must have disturbance monitoring equipment on larger machines.

5.3.8 Transient Stability Performance: Transient stability performance of the DER is the responsibility of the DER owner. Transient stability performance should be in accordance with the LDC's Transient Stability Criteria. The LDC may, at its discretion, elect to perform the necessary studies to evaluate transient stability performance. The cost of these studies will be borne by the DER owner as part of the System Impact Study.

5.4 Excitation Control: In addition to the normal excitation system and automatic voltage regulation equipment, the following controls are also required for each synchronous generator.

5.4.1 Overcurrent Limiter: The excitation system is to be provided with a current limiting device which will supercede or act in conjunction with the Automatic Voltage Regulator to automatically reduce excitation so that generator field current is maintained at the allowable limit in the event of sustained under-voltages on the distribution system. This device must not prevent the exciter from going to and remaining at the positive ceiling for 0.1 seconds following the inception of a fault on the power system.

5.4.2 Underexcitation Limiter: A limiter to prevent instability resulting from generator underexcitation is required.

5.4.3 Power System Stabilizer: LDC studies may identify the need for the use of power system stabilizers, depending on the plant size, excitation system type and settings, facility location, area distribution system configuration and other factors. This will be determined on a case-by-case basis.

5.5 Speed Governing: All synchronous generators shall be equipped with speed governing capability. This governing capability shall be unhindered in its operation consistent with overall economic operation of the DER facility. Overspeed protection in the event of load rejection is the responsibility of the DER owner.

5.6 Dynamic Performance Data: Dynamic performance data shall be made available to the LDC as part of the facility specifications and plans for evaluation by the LDC. This data is required to evaluate the system dynamic performance of the DER facility which includes but is not limited to transient stability. For synchronous generators, the required dynamic performance data are listed in Appendix B. For other types of generators, appropriate modeling data shall be made available to represent the generator in commonly used stability study software.

5.7 Automatic Generation Control (AGC): Depending upon various control area factors applicable to tie line and frequency regulation, provision for dispatch control of the DER facility by the LDC system control center AGC system may be required. This will be considered on a case-by-case basis and any provision for control by AGC should be included in a Connection Agreement between the DER owner and the LDC.

5.8 Black Start Capability: Depending upon the geographic location and other considerations applicable to system restoration in the event of a blackout, the provision of blackstart[1] capability may be required or desirable. The Connection Agreement is to address this matter. Responsibilities of the DER owner will be addressed in the Connection Agreement.

5.9 Unbalanced Electric Conditions

5.9.1 Voltage Balance: All three-phase generation shall produce balanced 60 Hz voltages. Voltage unbalance attributable to the DER combined generation and load shall not exceed 2.5% measured at the point-of-service. Voltage unbalance is defined as the maximum phase deviation from average as specified in ANSI C84.1, "American National Standard for Electric Power Systems and Equipment – Voltage Ratings, 60 Hertz."

5.9.2 Current Balance: Phase current unbalance attributable to the DER owner combined generation and load shall not exceed that which would exist with balanced equipment in service, measured at the point-of-common coupling. Situations where high unbalance in voltage and/or current originate from the distribution system are to be addressed in the Connection Agreement.

5.10 Harmonics and Flicker: The DER owner shall take responsibility for limiting harmonic voltage and current distortion and/or voltage flicker[2] caused by their DER equipment. Limits for harmonic distortion (including inductive telephone influence factors) are consistent with those published in the latest issues of ANSI/IEEE 519, "Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems." A specific example of harmonics and flicker criteria is given in Appendix C. LDC criteria requires that flicker occurring at the point of compliance shall remain below the Border Line of Visibility curve on the IEEE/GE curve for fluctuations less than 1 per second or greater than 10 per second. However, in the range of 1 to 10 fluctuations per second, voltage flicker shall remain below 0.4% (see Appendix C, Exhibit 1). Depending upon the nature of the generation and its location, the LDC may require the installation of a monitoring system to permit ongoing assessment of compliance with these criteria. The monitoring system, if required, will be installed at the DER owner's expense. Situations where high harmonic voltages and/or currents originate from the distribution system are to be addressed in the Connection Agreement.

[1] A blackstart capable generation facility is one that can be started without the aid of off-site power supplied by the distribution system.

[2] Flicker is an objectionable, low frequency, voltage fluctuation which can be observed through changes in intensity or color of illumination.

5.11 Abnormal System Conditions: Customer DER must be equipped with adequate protection to automatically trip[4] the unit off line during abnormal[5] system conditions, according to the following guidelines:

5.11.1 Induction Generator or Line-Commutated Inverter Interface

(a) Undervoltage or overvoltage, typically minus 10% with a base voltage of 120 volts, or plus 10%, respectively, with a base voltage of 120 volts, or equivalent service delivery voltage.

(b) For three phase generation, loss of balanced three-phase voltage or a single phasing condition[6]. Voltage unbalance under any condition shall not exceed 3% (calculated by dividing the maximum deviation from average voltage by the average voltage, with the result multiplied by 100)

5.11.2 Synchronous Generator, Alternator or Self-Commutated Inverter Interface

(a) Undervoltage or overvoltage, typically minus 10% with a base voltage of 120 volts, or plus 10%, respectively, with a base voltage of 120 volts, or equivalent service delivery voltage.

(b) Underfrequency or overfrequency, typically minus or plus 0.5 Hz at a 60 Hertz base frequency, respectively.

(c) For three-phase generation loss of balanced three-phase voltage or a single phasing condition. Voltage unbalance under any condition shall not exceed 3% (calculated as in section 5.11.1(b).

(d) When the LDC's frequency is outside the range of nominal frequency, the DER shall be constructed to cease to energize the LDC within 15 Cycles. By agreement of both the DER operator and the LDC operator, different settings maybe used for the under frequency and over frequency trip levels or time delays.

5.12 Additional protection: Customer DER, depending on the size, must include the following additional protection to avoid possible damage to the customer's DER equipment and the LDC's system during normal, as well as abnormal system conditions.

5.12.1 Ground detector to detect a circuit ground on the LDC system;

[4] To trip is to open the appropriate breaker to de-energize the voltage source.
[5] Abnormal system conditions include faults due to adverse weather conditions including but not limited to floods, lighting, vandalism, and other acts that are not under the control of the LDC. This may also result from improper design and operation of customer facilities resulting from non-compliance with accepted industry practices.
[6] A Single phasing condition occurs when one phase of the three phase supply line is disconnected. The generator would concentrate its output on the isolated phase, trying to maintain voltage on the faulted phase.

5.12.2 Individual phase overcurrent relays with voltage restraint;

5.12.3 Directional overcurrent relays to detect the directional flow of current in excess of a desired limit;

5.12.4 Synchronizing controls to insure a safe interconnection with the LDC's distribution system. The DER must be capable of interconnection with minimum voltage and current disturbances. Synchronous generator installations, as well as other types of installations, must meet the following: slip frequency less than 0.1 Hz, voltage deviation less than $\pm$ 10%, phase angle deviation less than $\pm$ 10 degrees, breaker closure time compensation (not needed for automatic synchronizer that can control machine speed).

5.12.5 Transfer trip receiver to provide tripping logic to the DER for isolation of the DER upon opening of the LDC's distribution circuits. (Depending upon generator size, a transfer trip scheme on the transmission or distribution side of the station may be required, only in the event that the customer does not have non-islanding protection requirements.)

5.12.6 Directional power relays to detect, under all system fault conditions, a loss of the LDC's primary source;

5.12.7 Adequate protection to the customer's facilities for high-speed reclosing operations on the LDC's subtransmission/transmission circuits, must be provided by the customer. The customer must supply relaying and detection to make sure that its machine trips off before the LDC performs a reclose operation. The LDC's reclosing scheme will not change to accommodate a DER owner's protection scheme that may undermine the LDC's system integrity.

5.12.8 The LDC, at the expense of the DER owner, will install a potential sensor indicator on the line side of the recloser in order that the LDC can make sure that the DER is de-energized before the LDC allows the breaker to reclose. This installation is necessary to protect the DER Owner's employees and equipment, and the LDC's employees and equipment. The customer has the responsibility of supplying the relaying and detection to make sure that his machine trips off line before the LDC performs a reclose operation.

5.12.9 Islanding: When the DER is capable of supplying energy to the LDC's system for 60 or more cycles (one second or more) during a fault, or when the distribution circuit, interconnected with the DER is de-energized from the LDC's source, the LDC will require additional protection equipment to isolate the DER from the LDC's system, in order to avoid unintentional islanding[3] of the DER. .

[3] Unintentional Island—an unplanned condition where one or more DERs and a portion of the electric utility grid remain energized through the point of interconnection.

In some cases, intentional islanding may be permitted when both their DER operator and the LDC desire such conditions.

5.12.9.1 Intentional Islanding: Intentional islands for distributed generators will only be established by mutual agreement and contractual arrangement that includes all parties – LDC (grid operator), distributed energy resource(s), and load customer(s).

5.12.9.2 An islanding study must be performed by the LDC for each intentional island including, but not limited to, the following:

(1) A planning study will verify that the entire island will operate within required voltage and frequency for each island configuration. It will also determine whether there is a requirement for upgrading or replacing LDC equipment or conductors in order to accommodate the anticipated load flows in the islanded condition.

(2) Stability studies will check generator-generator and generator-load interactions and verify that the island will be stable.

(3) Fault studies will ensure the protective relaying functions located at the generator will be able to properly detect faults at all parts of the island, and under all possible switching configurations and generator combinations that are not protected by customer owned protection schemes. These fault studies will check for relay de-sensitization and will determine whether protective relay settings on utility and/or customer owned protection schemes will require settings changes, scheme/equipment revisions, or wholesale replacement. These fault studies will determine what new protection in addition to that already in place will be required such as, but not limited to, additional relaying equipment at designated distribution system tie points to allow islanding upon grid trouble and to allow paralleling upon restoration of the grid.

5.12.9.3 The DER must have load following capability and sufficient voltage regulation capability such that the voltage and frequency of the island is maintained within the limits imposed on the LDC.

5.12.9.4 The DER cannot force customers who are physically a part of the island to purchase power from them. The DER must supply power to non-participating customers free of charge.

5.12.10 The protective relays required by the LDC and any auxiliary tripping relays associated with those relays shall be utility-grade devices.

5.12.11 Utility-grade relays are defined as follows: (1) Meet ANSI/IEEE Standards C37.90, C37.90.1 and C37.90.2.

(2) Have relay test facilities to allow testing without unwiring or disassembling the relay,
(3) Have appropriate test plugs/switches for testing the operation of the relay,
(4) Have targets to indicate relay operation.

5.13 Power factor must be maintained between 90% lagging and 90% leading unless otherwise agreed to by parties. If the customer DER imposes an unusual reactive burden on the LDC's system such that the customer's net load or net generation power factor exceeds 0.90 lead or lag, the customer may be required to install reactive corrective equipment. In the case of an induction generator application, VAR support may be required. Where VAR support is contemplated, the LDC should be consulted.

5.14 Customer equipment must have adequate fault interruption and withstand capacity, and adequate continuous current and voltage rating to operate properly[4] with the LDC's present and planned future system.

5.15 The DER owner can facilitate the LDC approval process for the DER interconnection by assuring that the DER interconnection equipment meets LDC pre-certification requirements. Conformance tests shall be performed by a manufacturer to confirm that the interconnection system design meets requirements. Factory tests shall be performed by a manufacturer in the factory before equipment is shipped. These tests should cover the testing of DC Current Injection, overvoltage protection, undervoltage protection, overfrequency protection, underfrequency protection, current unbalance, surge withstand capability, fast transient testing, islanding detection, dielectric testing, etc. This list is not all inclusive.

5.16 When inverter systems are intended to be used as the DER, they should be pre-tested, approved and listed by Underwriter's Laboratories or similar independent testing laboratories for harmonics and other specification issues such as frequency operating range and current-distortion levels.

5.17 When synchronous or induction generators are used for the DER, several types of data will be required by the LDC such as reactance data, field time constant data, etc. The customer must provide DER test data to the LDC.

5.18 Customer generation must operate and maintain voltage within normal LDC limits of $\pm$ 5% of 120 volts or equivalent service delivery voltage, at the interconnection point.

5.19 A ground fault sensing scheme may be required by the customer, depending on the type of transformer connection of the customer's DER to the LDC's system. This ground fault scheme will protect the customer's equipment from system ground faults that may occur in his system, or in the LDC's system to which the customer is connected.

[4] Properly, in this context, means within the acceptable utility or applicable industry established parameters.

5.20 The customer must notify the LDC in the event of a change in the design, size, or technology for the DER before final plans are implemented.

5.21 In large DER applications where telemetry is required, the following data, at a minimum, is required to be received by the LDC: MW out, MWHs out, MVARs (lead and lag) and DER breaker position (open or closed).

6.0 CUSTOMER OPERATING PROCEDURES

6.1 Voltage Disturbances: The DER facility must be capable of continuous non-interrupted operation within a steady-state voltage range during system normal conditions. This range varies based on the following table:

Response to Abnormal Voltages

Voltage	Maximum Trip Time (T)
V<60 (V<50%)	10 cycles
60≤V<106 (50%≤V<88%)	120 cycles
106≤V≤132 (88%≤V≤110%)	Normal Operation
132<V<165 (110%<V<137%)	120 cycles
165≤V (137%≤V)	6 cycles

(T) "Trip Time" refers to the time between the abnormal condition being applied and the inverter, or interconnection device, ceasing to energy the utility line. The inverter, or interconnection device, will actually remain connected to the utility to allow sensing of utility electrical conditions for use by the "reconnect" feature.

6.2 The DER facility must be capable of continuous, uninterrupted operation in the frequency range of 59.5 to 60.5 Hz. Limited time, non-interrupted operation is also expected outside this frequency range in accordance with the generator manufacturer's recommendation.

6.3 If high-voltage, low-voltage, or voltage flicker complaints arise from other customers due to the operation of customer DER, the customer may be required to disconnect its generation equipment from the LDC's system until the problem has been resolved.

6.4 Customer DER must not produce harmonic currents or voltages that will interfere with the LDC's metering accuracy and/or proper operation of facilities and/or with other customer loads. Such adverse effects may include, but are not limited to heating of wiring and equipment, overvoltage, communication interference, etc.

6.4.1 When a primary line fault occurs on the LDC's distribution circuit, the DER customer must trip off-line in 60 cycles (one second) or less, thus clearing and not sustaining a fault on the LDC's system.

6.5 The customer should not reconnect DER to the LDC's system after a trip from a system protection device, until the LDC's system is energized for a minimum of five minutes. If the customer need to connect a backup generator, in the event to serve to a critical load, he must open his main breaker or transfer switch, prior to generator hook up, in order to ensure no back feed into the LDC's distribution system. This is a critical safety requirement.

6.6 The customer may be required to discontinue parallel operation when requested by the LDC, so that maintenance and/or repairs can be performed on the LDC's facilities.

6.7 The customer will be responsible for damage caused to other customers and/or to the LDC, due to a malfunction, improper design, misoperation or human error of the customer's DER or controls.

6.8 The customer must notify the LDC in the event that the DER is removed from service on a permanent basis.

6.9 Net Demonstrated Real and Reactive Capabilities: Individual synchronous generators in the DER facility must make available the full steady-state over-and under-excited reactive capability given by the manufacturer's generator capability curve at any dispatch level. Tests that demonstrate this capability must be conducted and documented on a regular basis. Such documentation should be provided to the LDC. The LDC reserves the right to witness these tests.

6.10 Make-Before-Break Transfer: Make-before-break transfer is only permitted between two live sources which are in, or close to, synchronism. A transfer switch designed for automatic make-before-break transition shall be equipped with logic to prevent a transfer if the specifications for either the DER owner or the LDC's distribution system source fall outside of the synchronizing requirements recommended by the generator equipment manufacturer. Switch transfers made when the synchronizing requirements cannot be met shall be of the break-before-make type of transfer. The time that the DER owner's generation is permitted to operate in parallel with the LDC's distribution system during a make-before-break transfer shall be no greater than 100 milliseconds(6 cycles)

6.11 Operating Restrictions: Situations necessitating generation curtailments or forced outages as the result of unavailability of distribution facilities owned and/or operated by the LDC are to be addressed in a Connection Agreement with the DER owner.

6.12 Please refer to section 8.2 for additional responsibilities.

7.0 LDC PROTECTION REQUIREMENTS

7.1 Typically, distribution system fault protection is provided at the station recloser or breaker to clear temporary and/or permanent faults that may occur on the distribution system, due to lightning, tree contacts, animals, vehicle accidents and equipment failures. In areas where full protection coverage cannot be maintained by the station recloser or breaker, line reclosers and fuses (often single-phase devices) are used to provide protection. These devices protect sections or branches of the system and clear faults on the system when faults occur. For proper operation of the system, the protective devices in series will need to be coordinated for prompt clearing of the fault, and for avoidance of unnecessary operation of multiple protective devices. Accordingly, it is important for the LDC and customer protective devices to coordinate properly for safe and timely isolation of the faulted system or faulted equipment.

7.2 Transformer Requirements for DER applications: A dedicated transformer is required to mitigate harmonics and other abnormal conditions which may occur with other customers in the adjacent area, as a result of the DER installation

7.2.1 **New customer with DER**: A dedicated transformer is required. The customer is responsible for the total costs associated with the installation of a dedicated transformer.

7.2.2 **Existing customer-Dedicated transformer-planning to install DER**: If this customer is the only customer served from an existing transformer, there is no cost to the customer, since the transformer already exists.

7.2.3 **Existing customer planning to install DER**: If the existing transformer serves other customers in addition to this customer, then a separate transformer dedicated to the DER customer would be required. The customer is responsible for the total costs associated with the installation of a dedicated transformer.

7.3 To interconnect a three phase generator in parallel with the LDC's system at secondary voltage level where the customer is served by a single phase distribution line and transformation, the following is required:

7.3.1 The LDC will extend and/or construct three phase primary line and associated facilities to the customer's DER location, with the cost as the responsibility of the customer.

7.3.2 The LDC will install a dedicated three phase transformation having sufficient capacity to accommodate the customer's DER and load, with the cost as the responsibility of the customer.

7.4 For a customer to interconnect a three-phase generator in parallel with the LDC's system where the customer is served at the primary voltage level, the LDC will review distribution system protection facilities and customer protection facilities,

and make recommendations and check the coordination of protection devices between the two independent systems.

7.5 Although the customer provides the required protection devices, as specified in section 5.0, the LDC will not rely solely upon the customer's protection devices to prevent the transfer of energy into the distribution system during abnormal conditions, or when maintenance and/or repairs are being performed on the LDC's system. The LDC may need to modify existing relaying schemes on its own distribution system, depending on the location of the DER and the type of DER technology applied.

7.6 The LDC will specify settings for the DER's LDC-required relays to assure coordination between the DER's protective equipment and the LDC's system relays. It is the owner's responsibility to determine that its internal protective equipment coordinates with the required LDC protective equipment and is adequate to meet all applicable standards to which the DER is subjected.

7.7 The LDC further reserves the right to modify relay settings when deemed necessary to avoid safety hazards to utility personnel or the public and to prevent any disturbance, impairment, or interference with the LDC's ability to serve other customers.

7.8 If at any time it is determined that the use of the relay systems in Section 5.0, as well as this section, cannot provide adequate protection to the LDC's system, the DER owner shall additionally furnish and install at his expense, upon the request of the LDC, a transfer trip receiver(s) at his facility to receive tripping signals originating from the LDC location(s). This additional protection would also necessitate, at the owner's expense, the purchase and installation of transfer trip equipment at LDC location(s) and a communication channel between the LDC location(s) and the DER facility.

8.0 LDC OPERATING PROCEDURES FOR ITS EMPLOYEES/ CONTRACTORS

8.1 The transfer of electrical energy from customer-owned DER into the LDC's distribution system is possible, depending on the type of DER. Therefore, LDC employees must strictly adhere to LDC safety rules. Exhibit I includes examples from a LDC safety manual (Sections E.1.03 and E.4.02, respectively). Other articles, such as IEEE standards, may be applicable for DER interconnection as well, and these should be reviewed.

The LDC will advise the customer to disconnect and isolate all customer DER facilities from the LDC's system during abnormal conditions, such as system outages, emergencies and equipment maintenance. Furthermore, the LDC will advise the customer to disconnect all DER generation which affects the LDC's ability to control, maintain, and provide quality of service to other customers without any detrimental reduction in system frequency, voltage regulation, power

factor or detrimental increase in harmonic distortion. These requirements are spelled out in terms and conditions of the LDC's tariffs.

The LDC may install special tags at all transformer and/or isolating pole locations, interconnected with customer DER facilities, to warn LDC field personnel that a customer-owned energy source exists. LDC circuit maps and diagrams used by LDC operators or field personnel must include the location of customer-owned DER facilities and isolating devices/disconnect switch. Additional design requirements and/or safety controls or procedures could be required in the future.

Exhibit I

*Excerpts from the LDC's Safety Manual

E 1. General Precautions

1.03 All circuits and equipment shall be considered energized at full voltage until de-energized and grounded or where grounding is impractical, other precautions are taken to insure there is no possible energy source, including lightning, induced voltage or customer-owned generation facilities.

E 4. Working on De-energized Lines or Equipment

4.02 When taking lines or equipment requiring a Dispatcher's or Operator's clearance out of service, it shall first be de-energized by an appropriate switching device, such as disconnect, interrupter, circuit breaker, fuse or recloser. For work on equipment, isolating disconnecting switches on both sides of the equipment shall be opened. For work on lines, the line shall be disconnected from the electric circuit by a visible disconnecting means (except for totally enclosed units) and any other possible sources of energy including customer-owned generating facilities, and checked open. For totally enclosed units such as SF6, alternative methods for determining disconnection shall be used. Lines and equipment taken out of service shall be properly tagged.

*Note: Information from March 30, 1998-Revision of AEP Safety Manual

8.2 Disconnection and reconnection. The LDC may disconnect a DER from the LDC's system under the following conditions:

8.2.1 Expiration or termination of interconnection agreement. The interconnection agreement specifies the effective term and termination rights of the LDC and its customer. Upon expiration or termination of the interconnection agreement with a customer, in accordance with the terms of the agreement, the LDC may disconnect customer's facilities.

8.2.2 Non-compliance with the technical requirements specified in this document. The LDC may disconnect a distributed energy resource if the facility is not in

compliance with the technical requirements specified in this document. Within two business days from the time the customer notifies the LDC that the facility has been restored to compliance with the technical requirements of this document, the LDC shall have an inspector verify such compliance. Upon such verification, the customer in coordination with the LDC may reconnect the facility.

8.2.3 System emergency. The LDC may temporarily disconnect a customer's facility without prior written notice in cases where continued interconnection will endanger persons or property. (Verbal notice will be provided.) During the forced outage of the LDC's system, the LDC shall have the right to temporarily disconnect a customer's facility to make immediate repairs on the LDC's system. When possible, the LDC shall provide the customer with reasonable notice and reconnect the customer as quickly as reasonably practical.

8.2.4 Routine maintenance, repairs, and modifications. The LDC may disconnect a customer or customer DER with seven business days prior written notice of a service interruption for routine maintenance, repairs, and utility system modifications. The LDC shall reconnect the customer as quickly as reasonably possible following any such service interruption.

9.0 TESTING AND MAINTENANCE

The owner shall permit testing and maintenance of devices and control schemes provided by the owner for the protection of the LDC's distribution system by an LDC approved organization. Included in the testing and maintenance will be any initial set up, calibration, and check out of the required protective devices, periodic routine testing and maintenance, and any testing and maintenance required as the result of changes to protective devices by the owner or the LDC.

All testing and maintenance performed by the LDC approved organization shall be under the general surveillance of the LDC. This may include circuit breakers, circuit switches, power fuses, instrument transformers, switches, surge arresters, bushings, relays, and associated equipment (including battery and battery charger). Also, a copy of all test and maintenance reports shall be forwarded to the LDC.

If the owner's testing and maintenance program is not performed to the satisfaction of the LDC, or at the required maintenance interval, the LDC reserves the right to inspect, test, or maintain the protective devices required for the protection of the LDC's distribution system. If the owner's protective relaying is determined to be unsatisfactory, the LDC reserves the authority to disconnect the generation from the LDC's system.

10.0 METERING AND TELEMETRY

Telemetry is normally required for large DER applications where real time priced energy and/or demand monitoring are required by the customer, or under other special circumstances such as required by LDC contracts. The DER owner shall be responsible for the installation and operating costs of the metering equipment at the delivery point. The metering equipment may

include voltage and current transformers where necessary, as well as meters and test switches. The accuracy of the instrument transformers and meters will be 0.3 percent or better accuracy class for revenue metering. The overall accuracy of the metering will comply with established Public Service Commission guidelines for tariff metering. The metering equipment will be tested periodically as defined in the connection agreement and the test results will be available to all involved parties. The meters, test switches and wiring termination equipment shall be sealed by LDC personnel.

At least (N-1) metering elements will be used to measure all real and reactive power crossing the metering point, where N is the number of wires in service including the ground wire. Bi-directional watt-hour energy flow, and where required, var-hour energy flow, will be registered separately. Depending on the tariffs to be applied, appropriate demand quantities will be metered in terms of kilowatts, kilovars or kilovolt-amperes.

If, at the discretion of the LDC, the DER necessitates real-time telemetry to the LDC system control center, the owner shall install and operate at their expense the communication channel, the LDC approved telemetry equipment and associated devices.

At the discretion of the LDC, generation control facilities and supervisory control and data acquisition of specific electrical devices from the LDC's system control center may be necessary to integrate the generation into the LDC's control area. Such additional facilities, including required communication channels, shall, if required, be furnished and installed at the owner's expense. The requirement for data acquisition and control will depend on the generation capacity, system location and voltage, and the net generation input into the LDC's system.

If required, suitable telemetry equipment will be installed at the metering point to provide real-time telemetry data to the LDC and to all other participating parties. Telemetry equipment will include transducers, remote terminal units, modems, telecommunication lines, and any other equipment of the same or better function. The remote terminal unit, or equivalent device, must have multiple communication ports to allow simultaneous communications with all participating parties. That device will accommodate data communication requirements specified by each participating parties' control center, including communication protocol, rate and mode (either synchronous or asynchronous). All metered values provided to the telemetry equipment will originate from common metering equipment. All transducers used for telemetry will have at least 0.2 percent accuracy. As part of real-time data to be provided, the LDC has the right to require the status and remote control of switching devices at the Receipt and/or Delivery Points.

A continuous, accumulating record of megawatt-hours and megavar-hours will be provided by means of the registers on the meter. Freezing accumulation data for distribution will be taken every clock hour. The freezing signals synchronized to within 2 seconds of Universal Coordinated Time must be provided by only one of the agreed-upon participating parties. If the freeze signal is not received within a predefined time window, the remote terminal unit, or equivalent device, will be capable of freezing data with its own internal clock.

The metering, if external power supply is required, and telemetry equipment will be powered from a reliable power source, such as a station control battery, in order to allow the equipment to be continuously operational under any power outage situations. Proper surge protection will be provided for each communication link to protect communication hardware from ground-potential-rise due to any fault conditions. A separate communication media shall be provided to allow the LDC to remotely retrieve billing quantities from the meters. When real-time telemetry is required, a back-up data link must be provided in case of the outage of the primary telemetry line. The back-up link can be a data communication link between involved control centers; the party requesting service is responsible for furnishing the back-up link.

Data acquisition and control information will typically include, but not be limited to:

1. desired generation MW set point,
2. automatic generation control status (on, off),
3. generator availability,
4. generation MW, MVAR output,
5. generator minimum and base MW capability,
6. generator MW AGC high limit and low limit,
7. connection facilities' breaker status/control/alarms,
8. connection facilities' MW and MVAR line values and bus voltage, and
9. generator and substation metering (MWH) data.

11.0 VOICE COMMUNCIATIONS

11.1 Normal--At the LDC's request, the owner shall provide a dedicated voice communication circuit[1] to the LDC's system control center. Such a dedicated voice communication circuit would originate from the owner's office staffed 24 hours a day and would be typically required for generation facility synchronization and operation within the LDC's control area.

All other normal voice communication concerning facility operations shall be conducted through the public telephone network to the system control center phone number(s) issued by the LDC.

11.2 Emergency--Voice communications in the event of a distribution system or capacity emergency shall use the dedicated voice circuits, or public telephone network and phone number(s) designated for emergency use.

In the event of a distribution system or capacity emergency, the owner may be notified by the LDC's system control center. Specific instructions may also be given regarding the operation of the DER owner's unit(s) depending on the nature of the emergency. These instructions may consist of voltage schedule changes, real and/or reactive dispatch changes, or instructions to shut down or start-up the owner's unit(s). It is the owner's responsibility to

[1] pilot wire or a wire circuit for the transmission of audio-frequency tones. Preferably, these should be owned by the user for protection, but leased lines from telephone companies have been and are in use.

ensure that the unit operators follow all instructions given by the LDC control center during system emergencies.

12.0 COST RESPONSIBILITY

The DER owner shall reimburse all costs incurred by the LDC to provide operation of the DER. The costs include but are not limited to:

1. Each review of the engineering and engineering drawings associated with the DER.

2. Metering not covered under the distribution tariff of general applicability.

3. The necessary facility modifications on the LDC's distribution system to adequately accommodate the operation of the owner's DER.

4. LDC facility replacements, modifications, and/or enhancements due to exceeded ratings directly caused by or which could potentially be caused by the power flow attributed to the DER.

5. Communications circuits required for telemetry, protective relaying, and/or voice communications with the DER. Cost responsibility will depend upon the services required by the DER owner and/or the LDC.

6. Protective devices to be provided by the owner for the protection of the LDC's distribution system.

7. Protective relaying, including the transfer trip transmitter(s), receiver(s), and associated equipment, not on the owner's premises required by the LDC due to the addition of the DER.

8. Protective relaying required to protect the DER from faults and abnormal system operating conditions.

9. Additional regulating and control devices required to meet the conditions set forth in Section 5.0. This would include any equipment necessary for suppression of harmonic current and/or voltages.

10. LDC equipment replacements or modifications due to an increase in available short circuit fault current directly caused by the addition of the DER owner's equipment.

11. Calibration, testing, and maintenance of relays and protective devices provided by the DER owner for the protection of the LDC's distribution system.

12. Telemetering equipment to provide necessary telemetry to the LDC system control center, when necessary.

13. Future changes associated with the DER as a result of changing conditions on the LDC's system.

14. In the event that the LDC finds a problem, the LDC reserves the right to charge the customer a fee for LDC review of drawings and diagrams of customer-owned DER equipment and for LDC field check of equipment to verify compliance with design requirements.

15. The LDC will be held harmless for damages caused to other customers and/or to the LDC, due to a malfunction, improper design, misoperation or human error of the customer's DER or controls.

16. Studies performed by LDC pertaining to the DER.

13.0 DESIGN REVIEW

The DER owner is responsible for submitting all specifications and detailed plans to the LDC for review and approval prior to receiving permission to connect to the LDC's distribution system.

The LDC requires notification in letter-form for the proposed installation of any generation utilizing a make-before-break transfer switch. In order to allow for timely exchange of information, this notification should be provided during the preliminary planning stages of the proposed facility.

The DER owner should submit an application to the LDC requesting the proposed DER interconnection to the LDC's distribution system. A Notification of Intent to Install and Operate DER, as shown in Appendix E, must be submitted, as well as the data requested in Appendix B, if applicable. The LDC will respond within 4 weeks of the customer application for pre-certified DER units, and within 6 weeks for requests not involving pre-certified DER equipment. The LDC requires a review of the DER owner's plans for the generation in order to provide for compatibility of design and operation with the LDC's distribution system.

13.1 Notification of Intent

The DER owner is required to complete and forward the Notification of Intent to Install and Operate DER (Appendix A) to a LDC customer service representative with the appropriate deposit and all necessary attachments that shall include:

13.1.1 A summary, signed by the DER owner management, that provides a general description of the intended manner of operation for the generation.

13.1.2 Three copies of drawings and specifications prepared and approved by a registered professional engineer adequately detailing the facility location and proposed location of the generation facilities with respect to the DER owner's desired point of electric service and the appropriate disconnecting devices identified in Section 5.3.3.

13.1.3 Three copies of a comprehensive single-line diagram prepared and approved by a registered professional engineer. This information must comprehensively show the DER owner's intended configuration for operation including switching devices, transformers, generation facility, protective devices, metering devices, capacitors, proposed conductor sizes, etc.

The LDC will review the information supplied with the Notification of Intent to Install and Operate DER, and provide an appropriate engineering and operational comments and/or concerns that must be addressed and jointly resolved with the LDC. This review will also include a summary addressing other tangible responsibilities and associated estimated costs the DER owner will incur as reflected in Section 12.0 of this document.

13.2 Facility Data

As described in section 5.15, the DER owner can facilitate the LDC approval process for the DER interconnection by assuring that the DER interconnection equipment meets LDC pre-certification requirements.

The purpose of DER facility data to be provided to the LDC by the DER owner is to ensure proper coordination to protect against equipment or facility damage, to mitigate safety hazards to LDC personnel and the public, and to minimize disturbances, impairment, or interference with the LDC's ability to serve other distribution system users.

13.2.1 Data on Equipment to be Installed

13.2.1.1 Interrupting Devices and Relays--Complete manufacturer's data for interrupting devices and relays or fuses used for the protection of the LDC's system and the generation.

13.2.1.2 Power Transformers--Complete nameplate or test sheet data, including manufacturer, serial number, high- and low-side voltage taps, kVA ratings, impedance, load loss and no load loss watts, high- and low-side voltage winding connections, low-side voltage winding grounding (if used), and high voltage inrush current.

13.2.1.3 Power Capacitors-Location, kV and kVAR rating of capacitor banks, number of units, and bank configuration.

13.2.2 Data on the generation protection equipment, including make-before-break transfer switches, fuses, breakers, relays, relay settings associated with the proposed generation, and detailed schematic diagrams of protective relaying proposed for the LDC'S distribution system.

Complete manufacturer's data and specifications for make-before-break transfer switches, including transfer times and conditions of transfer, testing procedures, equipment schematics, and backup protection.

13.2.3 Information on characteristics of load, such as initial and near future expected load, power factor of such load, and dynamic (flicker, harmonics, etc.) character of such load.

13.2.4 Minimum and maximum required low-side operating voltages.

13.2.5 Generator Data:

a. Type (synchronous, induction, dc with solid-state inverter, etc.);
b. Nameplate data and ratings, including any rectifying, regulating, or inverting equipment;
c. Harmonic content at full rated output;
d. Detailed Dynamic Performance Data in accordance with Appendix B.
e. Real and Reactive capabilities at scheduled voltages.

13.2.6 Electric one-lines and schematic diagrams showing the generation, the interconnecting facility with the LDC's distribution system, and the protective relaying.

14.0 INSPECTION REQUIREMENTS

Before a DER facility can be energized, it must pass a final inspection by LDC personnel. The LDC will inspect all substation equipment from the point of interconnection to the first protective fault interrupting device. This may include circuit breakers, circuit switchers, power fuses, instrument transformers, switches, surge arresters, bushings, and relays and associated equipment (including battery and battery chargers). The inspection will consist of a visual inspection of all major equipment as well as review of required test results.

15.0 FINAL DOCUMENTATION

The LDC shall receive final documentation of the DER facility that replaces the above specifications and data submitted for the design review under Section 13.0 once the facility is ready for operation.

Prior to operation of a DER facility, the DER owner shall supply to the LDC three copies of all final electric one-lines, equipment data, and schematic diagrams. Subsequent revisions affecting the generation shall be documented with three copies of the revised electric one-line and schematic diagrams.

16.0 APPROVAL

The construction, testing, and maintenance of the protective equipment provided by the DER owner for protection of the LDC's distribution system shall be subject to review and approval by the LDC.

Prior to establishing service for operation, the DER owner shall obtain approval from the LDC for the DER, electrical equipment specifications, and operating procedures.

Final approval for operation of a DER owner's generation will be issued by the LDC. A signed contractual document with the LDC for DER is required for final approval. Failure to meet any of the requirements stated herein to the satisfaction of the LDC may result in a refusal to permit operation of the DER.

Review and approval by the LDC of the proposed DER facility specifications and plans shall not be construed as confirming or endorsing the design or warranting the safety, durability, reliability, adequacy, or otherwise of the generation facility.

17.0 SPECIAL PROVISIONS

Special provisions may be made with operators of small power production facilities and other co-generators pursuant to rules of the Federal and/or State agencies of the applicable regulatory jurisdiction.

18.0 COORDINATION WITH OTHER CODES, STANDARDS, AND AGENCIES

The information contained in this document is supplementary to and does not intentionally conflict with or supersede the National Electric Code (NEC), and the National Electric Safety Code (NESC), as approved by the American National Standards Institute (ANSI) or such federal, state and municipal laws, ordinances, rules or regulations as may be in force within the cities, towns or communities in which the LDC furnishes electric service. It is the responsibility of the DER owner to conform to all applicable national, state and local laws, ordinances, rules, regulations, codes, etc.

19.0 INDEMNIFICATION

The use and reliance upon the information contained in this document shall in no way relieve the DER owner from the responsibility to meet NEC and NESC requirements governing their design, construction, operation, and materials.

The DER owner, for itself, its successors, assigns and subcontractors will be required to pay, indemnify and save the LDC, its successors and assigns, harmless from and against any and all court costs and litigation expenses, including legal fees, incurred or related to the defense of any action asserted by any person or persons for bodily injuries, death or property damage arising or in any manner growing out of the use and reliance upon the information provided by the LDC.

Reliance upon the information in this document shall not relieve the DER owner from responsibility for the protection and safety of the general public.

APPENDIX A

One Line Diagrams

FIGURE 1—Inverter Application

FIGURE 2—Synchronous Generator Application
Primary Service

FIGURE 3—Synchronous Generator Application
Secondary Service

FIGURE 4—Induction Generator Application
Primary Service

FIGURE 5--Induction Generator Application
Secondary Service

APPENDIX B

Generation Dynamic Performance Data

Customer Name _____ Date ___/___/___

GENERATOR DATA
UNIT RATINGS

kVA	_____	_____ °F	Voltage		_____
Power Factor		_____	H_2 psig		_____
Speed (RPM)		_____	Connection (e.g. Wye)		_____
Short Circuit Ratio		_____	Frequency, Hertz		_____
Stator Amperes at Rated kVA		_____	Field Volts		_____
Max Turbine MW	_____	_____ °F			

REACTANCE DATA (PER UNIT-RATED KVA)	**DIRECT AXIS**		**QUADRATURE AXIS**	
Synchronous – saturated	Xdv	_____	Xqv	_____
Synchronous – unsaturated	Xdi	_____	Xqi	_____
Transient – saturated	X'dv	_____	X'qv	_____
Transient – unsaturated	X'di	_____	X'qi	_____
Subtransient – saturated	X"dv	_____	X"qv	_____
Subtransient – unsaturated	X"di	_____	X"qi	_____
Negative Sequence – saturated	X2v	_____		
Negative Sequence – unsaturated	X2i	_____		
Zero Sequence – saturated	X0v	_____		
Zero Sequence – unsaturated	X0I	_____		
Leakage Reactance	Xlm	_____		

FIELD TIME CONSTANT DATA (SEC)

Open Circuit	T'do	_____	T'qo	_____
Three-Phase Short Circuit Transient	T'd3	_____	T'q	_____
Line to Line Short Circuit Transient	T'd2	_____		
Line to Neutral Short Circuit Transient	T'd1	_____		
Short Circuit Subtransient	T"d	_____	T"q	_____
Open Circuit Subtransient	T"do	_____	T"qo	_____

ARMATURE TIME CONSTANT DATA (SEC)

Three Phase Short Circuit	Ta3	_____
Line to Line Short Circuit	Ta2	_____
Line to Neutral Short Circuit	Ta1	_____

ARMATURE WINDING RESISTANCE DATA (PER UNIT)

Positive	R1	_____		
Negative	R2	_____		
Zero	R0	_____		
Rotor Short Time Thermal Capacity $I2^2t$	=	_____		
Field Current at Rated kVA, Armature Voltage and PF	=	_____	amps	
Field Current at Rated kVA and Armature Voltage, 0 PF	=	_____	amps	
Three Phase Armature Winding Capacitance	=	_____	microfarad	
Field Winding Resistance	=	_____	ohms	_____ °C
Armature Winding Resistance (Per Phase)	=	_____	ohms	_____ °C

COMBINED TURBINE-GENERATOR-EXCITER INERTIA DATA

Inertia Constant, H = _____ kW sec/kVA
Moment-of-Inertia, WR^2 = _____ lb. $ft.^2$

CURVES

Saturation, Vee, Reactive, Capacity Temperature Correction

GENERATOR STEP-UP TRANSFORMER DATA

RATINGS

Capacity Self-cooled/maximum nameplate _____/_____ kVA

Voltage Ratio Generator side/System side _____/_____ kV

Winding Connections Low V/High V (Delta or Wye) _____/_____

Fixed Taps Available _____

Present Tap Setting _____

IMPEDANCE

Positive Z1 (on self-cooled kVA rating) _____ % _____ X/R

Zero Z0 (on self-cooled kVA rating) _____ % _____ X/R

EXCITATION SYSTEM

Identify appropriate IEEE model block diagram of excitation system and power system stabilizer (PSS) for computer representation in power system stability simulations and the corresponding excitation system and PSS constants for use in the model.

GOVERNOR SYSTEM

Identify appropriate IEEE model block diagram of governor system for computer representation in power system stability simulations and the corresponding governor system constants for use in the model.

APPENDIX C

Voltage Flicker Criteria and Harmonic Distortion Criteria

AEP Voltage Flicker Criteria and Harmonic Distortion Criteria

This document summarizes AEP's policy on voltage flicker and harmonic distortion for customers connected to the electrical system via a Company dedicated transformer or a Customer owned transformer. The term Company is defined as American Electric Power (AEP). The term Customer is defined as the party connected to the AEP System.

I. POINT OF COMPLIANCE – The point where the Company dedicated transformer or Customer owned transformer connects to the Company system will be the point where compliance with the voltage flicker and harmonic distortion requirements are evaluated.

II. VOLTAGE FLICKER CRITERIA – The Company requires that the voltage flicker occurring at the point of compliance shall remain below the Border Line of Visibility curve on the IEEE/GE curve for fluctuations less than 1 per second or greater than 10 per second (see Exhibit 1). In the range of 1 to 10 fluctuations per second, the voltage flicker shall remain below 0.4%.

The Customer agrees that under no circumstances will it permit the voltage flicker to exceed the Company criteria, whether or not complaints are received or service/operational problems are experienced on the Company subdistribution or distribution system. Should complaints be received by the Company or other operating problems arise, or should the Customer flicker exceed the borderline of visibility curve, the Customer agrees to take immediate action to reduce its flicker to a level at which flicker complaints and service/operational problems are eliminated.

Corrective measures could include, but are not limited to, modifying production methods/ materials or installing, at the Customer's expense, voltage flicker mitigation equipment such as a static var compensator. The Company will work collaboratively with the Customer to assess problems, identify solutions and implement mutually agreed to corrective measures.

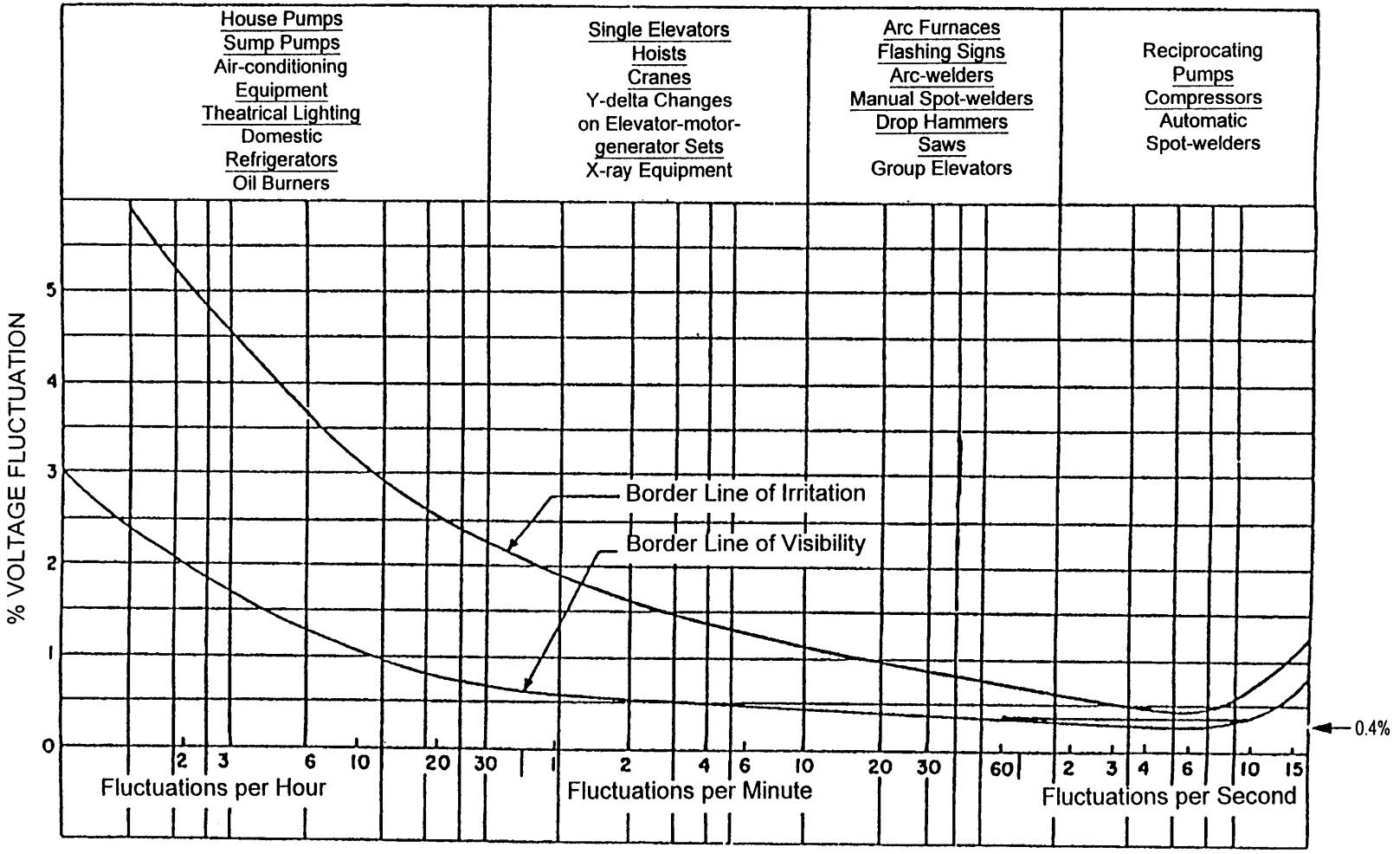
If the Customer fails to take corrective action after notice by the Company, the Company shall have such rights as currently provided for under its tariffs, which may include discontinuing service, until such time as the problem is corrected.

III. HARMONIC DISTORTION CRITERIA - The Company also requires that the Customer's operation be in compliance with the Company's Harmonic Distortion Guidelines (see Exhibit 2). These requirements are based on IEEE Standard 519, "IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems".

The Customer agrees that the operation of motors, appliances, devices or apparatus served by its system and resulting in harmonic distortions in excess of the Company's Requirements will be the Customer's responsibility to take immediate action, at the Customer's expense, to comply with the Company's Harmonic Distortion Requirements.

The Company will work collaboratively with the Customer to assess problems, identify solutions and implement mutually agreed to corrective measures.
If the Customer fails to take corrective action after notice by the Company, the Company shall have such rights as currently provided for under its tariffs, which may include discontinuing service, until such time as the problem is corrected.

Exhibit 1



Composite curve of voltage flicker studies by General Electric Company, *General Electric Review*, August 1925; Kansas City Power & Light Company, *Electrical World*, May 19, 1934; T&D Committee, EEI, October 24, 1934, Chicago; Detroit Edison Company; West Pennsylvania Power Company; Public Service Company of Northern Illinois.

Relations of Voltage Fluctuations to Frequency of Their Occurrence (Incandescent Lamps)

AEP HARMONIC DISTORTION REQUIREMENTS

The AEP Harmonic Distortion Requirements shown below are based on the information presented in the IEEE Standard 519, approved in 1992 and titled, "IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems." The voltage limits are intended to be used to gauge the acceptability of harmonic magnitudes on the transmission systems, while the current limits are applicable to individual customers injecting harmonic currents at the point of common coupling (PCC).

HARMONIC VOLTAGE DISTORTION (THD_V) LIMITS

Bus Voltage at PCC	Individual Harmonic Voltage Distortion (%)	Total Voltage Distortion THD_V (%)
$\leq$ 69 kV	3.0	5.0
69 kV < v $\leq$ 161 kV	1.5	2.5
Above 161 kV	1.0	1.5

HARMONIC CURRENT DEMAND DISTORTION (TDD) LIMITS

MAXIMUM HARMONIC CURRENT DISTORTION IN % OF BASE QUANTITY Harmonic Order (Odd Harmonics)						
v $\leq$ 69 kV						
I_{SC}/I_L	<11	11≤h<17	17≤h<23	23≤h<35	35≤h	TDD
<20	4.0	2.0	1.5	0.5	0.3	5.0
20-50	7.0	3.5	2.5	1.0	0.5	8.0
50-100	10.0	4.5	4.0	1.5	0.7	12.0
100-1000	12.0	5.5	5.0	2.0	1.0	15.0
>1000	15.0	7.0	6.0	2.5	1.4	20.0
69 kV < v $\leq$ 161 kV						
<20*	2.0	1.0	0.75	0.3	0.15	2.5
20-50	3.5	1.75	1.25	0.5	0.25	4.0
50-100	5.0	2.25	2.0	0.75	0.35	6.0
100-1000	6.0	2.75	2.5	1.0	0.5	7.5
>1000	7.5	3.5	3.0	1.25	0.7	10.0
161 kV < v						
<50	2.0	1.0	0.75	0.3	0.15	2.5
≥50	3.0	1.5	1.15	0.45	0.22	3.75

Where I_{SC} = Maximum short circuit at PCC
I_L = Load current at the time of the maximum metered amount

*All power generation equipment is limited to these values of current distortion, regardless of actual I_{SC}/I_L.

Even harmonics are limited to 25% of the odd harmonic limits above.

RDR2-12.LWP

Definitions

- **Harmonic Voltage Distortion** is to be normalized to the nominal system voltage and calculated using Equation 1.

TOTAL VOLTAGE HARMONIC DISTORTION (THD_v) in percent:

$$THD_v = \frac{\sqrt{\sum_{n=2}^{\infty} V_n^2}}{V_o} \times 100\% \qquad (Eq.1)$$

Where:

V_n = Magnitude of Individual Harmonics (RMS)
V_o = Nominal System Voltage (RMS)
n = Number of Harmonic Order

- **Harmonic Current Distortion** is to be normalized to the customer's load current at the time of the maximum metered demand which occurred over the preceding twelve months for existing customers and the customer's anticipated peak demand for new customers. For existing customers who are increasing their load, the projected demand should be used. The harmonic current demand distortion (TDD) should be calculated using Equation 2.

TOTAL CURRENT DEMAND DISTORTION (TDD) in percent:

$$TDD = \frac{\sqrt{\sum_{n=2}^{\infty} I_n^2}}{I_L} \times 100\% \qquad (Eq.2)$$

Where:

I_n = magnitude of Individual Harmonic (RMS)
I_L = Load Current at the Time of the Maximum Metered Demand
n = Harmonic Order

- **PCC - Point of Common Coupling.** The location where the customer accepts delivery of electrical energy from the utility.

Field Measurements

To gauge the acceptability of field measured harmonic distortion, a statistical evaluation of the data is to be performed. Measurements should be taken at five minute intervals or less over a minimum of 24 hours. For the measured data to be considered acceptable, two criteria must be met: 1) 95% of the measured data must fall below the limits stated; 2) no measured data shall exceed the limits specified by more than 50% of the absolute upper limit value.

Communication Interference Limits (I*T)

EXHIBIT 4

As stated in IEEE Standard 519, it is difficult to place specific limits on the telephone influence which the harmonic components of current and voltage can inflict. Hence, IEEE Standard 519 outlines a range of values where problems could occur (refer to the table below). The actual interference to voice communication systems in proximity to the power system is dependent upon a number of factors not under the control of the utility or customer. These factors will vary from location to location and from time to time as the state-of-the-art of inductive coordination progresses.

IEEE Standard 519 - Balanced I*T Guidelines		
Category	Description	I*T
I	Levels most unlikely to cause interference	<10,000
II	Levels that might cause interference	10,000 to 25,000
III	Levels that probably will cause interference	> 50,000

The limit applicable to AEP is the upper bound limit of the I*T levels that might cause interference on telephone systems. Thus, the customer induced harmonics shall not result in an I*T product to exceed 25,000 weighted amperes per phase, applicable to both the transmission and distribution systems. Residual I*T should also be minimized. Residual I*T is I_G*T, where I_G is the earth return current and is defined as the difference between the phasor sum of phase currents and neutral current. The I*T calculation is to be performed using Equation 3. The weighting of harmonic currents should conform to the 1960 TIF curve shown below.

$$I*T = I*TIF = \sqrt{\sum_{n=1}^{K} (I_n * W_n)^2} \quad weighted\ amperes \qquad (Eq.3)$$

Where:

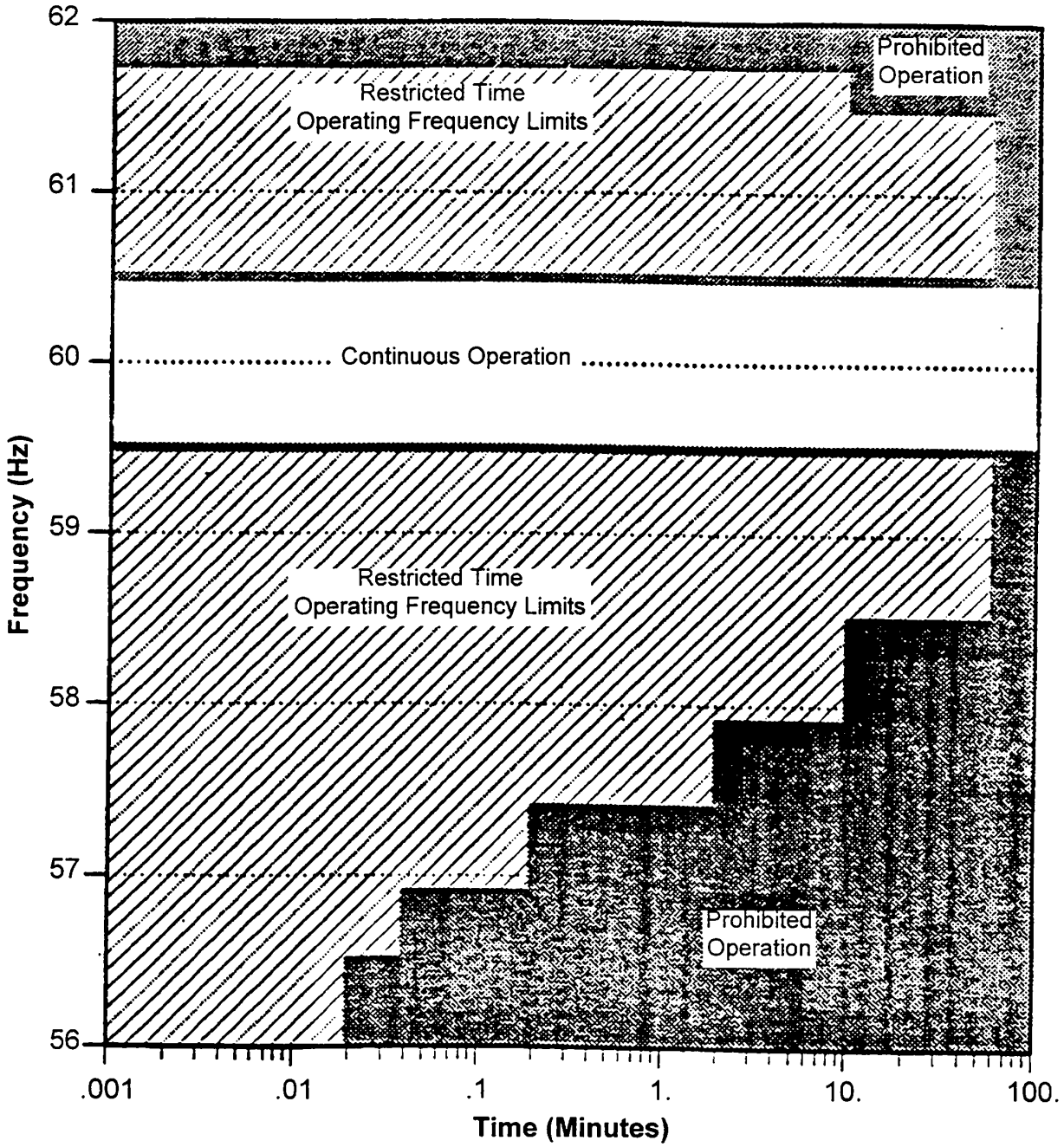
I = Current of individual harmonics, amperes, RMS
T = Telephone Influence Factor (TIF)
W_n = Single frequency TIF weighting at frequency n (refer to table and chart below)
K ≤ 42, Maximum harmonic order

FREQ	TIF (W)	FREQ	TIF (W)	FREQ	TIF (W)	FREQ	TIF (W)
60	0.5	1020	5100	1860	7820	3000	9670
180	30	1080	5400	1980	8330	3180	8740
300	225	1140	5630	2100	8830	3300	8090
360	400	1260	6050	2160	9080	3540	6730
420	650	1380	6370	2220	9330	3660	6130
540	1320	1440	6650	2340	9840	3900	4400
660	2260	1500	6680	2460	10340	4020	3700
720	2760	1620	6970	2580	10600	4260	2750
780	3360	1740	7320	2820	10210	4380	2190
900	4350	1800	7570	2940	9820	5000	840
1000	5000						

APPENDIX D

Generation Abnormal Frequency Operating Allowance

Generation Abnormal Frequency Operating Allowance



APPENDIX E

Notification of Intent to Install and Operate DER
Interconnected
With the LDC's Distribution System

Title	NOTIFICATION OF INTENT TO INSTALL AND OPERATE DISTRIBUTED ENERGY RESOURCE INTERCONNECTED WITH THE LOCAL DISTRIBUTION COMPANY'S (LDC) DISTRIBUTION SYSTEM	Page: Revision: Date:	1 of 4 5/18/2000

PURPOSE: The information to be provided in this Notification of Intent to Install and Operate a Distributed Energy Resource (DER)is necessary to evaluate and successfully integrate the DER facility within the LDC's distribution system and to provide for compatible operation of the integrated facilities. Failure to comply with the LDC Tariffs and Regulations filed with the Federal and State agencies having jurisdiction in the LDC's operating area may result in discontinuation of service or refusal to furnish service to the DER.

FILING: Any DER owner who plans to install generation that will be connected to the interconnected elements of an electric service supplied from the LDC's distribution system is to complete this document and submit it to a LDC Customer Service representative. Any subsequent change in the information supplied by the DER owner on this document is to be communicated to the LDC Customer Service representative by the DER owner as soon as available.

NON-REFUNDABLE FEE/OTHER COSTS: The DER owner is required to pay a nonrefundable fee according to the established fee schedule titled" Distributed Generation Interconnection Study Non-Refundable Fee Structure." The DER owner shall reimburse the LDC for all costs incurred by the LDC for facilities and services required to review, evaluate and provide for operation of the **Owner's** generation, including, but not limited to, the evaluation of information provided in this document. Following the project completion, customer-written notification of the project termination, or other interval as determined by the LDC, an accounting of the charges due the LDC less the non-refundable fee will be submitted to the DER owner.

1.0 OWNER INFORMATION

Entity/Requester/Company Name: _____
Facility Owner's Name: _____
Mailing Address: _____
City: _____ County: _____ State: _____ Zip Code: _____

2.0 PROJECT DESIGN/ENGINEERING INFORMATION

Company: _____
Mailing Address: _____
City: _____ County: _____ State: _____ Zip Code: _____
Contact Representative: _____ Phone No. _____

3.0 FACILITY INFORMATION

3.1 Does the **Owner's** proposed generator facility quality as a PURPA facility?
_____ Yes _____ No
If yes, attach a copy of the required information the **Owner** has filed or proposes to file with the Federal Energy Regulatory Commission.

3.2 Does the **Owner** propose to export power to the LDC's distribution system?
_____ Yes _____ No
If yes, indicate the proposed contract type to be made with LDC:
(a) Proposed Contract Capacity in kW to LDC _____
(b) Proposed Yearly kWh Sales to LDC _____
(c) Indicate Sales Schedule _____ kW On-Peak _____ kW Off-Peak
_____ kWh On-Peak _____ kWh Off-Peak

3.3 How many generating units does the owner propose to operate? _____
Specify the proposed operating date for each unit: _____ _____
_____ _____ _____ _____ _____

4.0 ESTIMATED OPERATIONAL INFORMATION: This information will be used to properly determine the capacity interfacing requirements for the **Owner's** proposed generation facility, and establish maintenance, supplementary, and backup power requirements.

4.1 Generator Operating Hours/Year: _____

4.2 The Generation System will operate in the following mode:
- ✎ Base Load On-Peak Only
- ✎ Base Load 24 Hours a Day
- ✎ Peak Shaving
- ✎ Emergency/Maintenance Only

4.3 Energy Generated MWH/Year: _____

4.4 Min. and Max. Anticipated Facility Load with Generator not Operating:
Minimum - _____ kW _____ kVA Maximum - _____ kW _____ kVA

4.5 Min. and Max. Anticipated Facility Load with Generator Operating:
Minimum - _____ kW _____ kVA Maximum - _____ kW _____ kVA

4.6 Specify the contract capacity desired:
_____ kW _____ kVA

NOTE: Specified Supplementary Capacity plus Specified Backup Capacity must equal the Specified Contract Capacity.

5.0 GENERATION EQUIPMENT INFORMATION

The following data is to be provided for each generating unit. Additional copies may be submitted for multiple units.

5.1 Energy Resource Data

Manufacturer (if available): _____

Model: _____

Type: ✎ Synchronous ✎ Induction ✎ Inverter

Frequency (Hz): _____

Rated Output: _____ kW _____ kVA

Rated Power Factor (%): _____ Rated Voltage (Volts): _____

Rated Amperes: _____

5.2 Prime Mover

Manufacturer (if available): _____

Model: _____

Rated Horsepower: _____ Maximum Horsepower: _____

Type:

- ❑ Steam Turbine
- ❑ Fuel cell
- ❑ Combustion Turbine
- ❑ Induction
- ❑ Synchronous
- ❑ Wind
- ❑ Battery
- ❑ Other (Specify): _____

ENERGY Source: ✎ Coal ✎ Oil ✎ Gas

- ❑ Off-peak utility
- ✎ Renewable (Specify) _____
- ✎ Other (Specify) _____

6.0 ATTACHMENTS OWNER TO PROVIDE WITH THIS NIOG

6.1 A summary, signed by the **Owner** management, that provides a general description of the intended manner or operation for the DER facility.

6.2 Three copies of drawings and specifications prepared and approved by a registered professional engineer adequately detailing the facility location and proposed location of the **Owner's** generation facilities with respect to the **Owner's** desired point of electric service and the appropriate disconnecting devices.

6.3 Three copies of a comprehensive single-line diagram prepared and approved by a registered professional engineer. This information must comprehensively show the **Owner's** intended configuration for operation including switching devices, transformers, generation facility, protective devices, metering devices, capacitors, proposed conductor sizes, etc.

7.0 OWNER AUTHORIZATION: I, the undersigned and authorized representative of the above DER facility, acknowledge that the aforementioned information is to be used for a review process performed by the LDC who will subsequently provide appropriate engineering and operational comments and/or concerns that must be addressed and jointly resolved with the LDC.

Owner permission to operate generation in parallel with the LDC will only be granted after specified LDC requirements and contractual commitments are met. I also acknowledge receipt from a LDC Customer Service Representative of a document titled "Requirements for Connection of DER Facilities to the LDC's Distribution System."

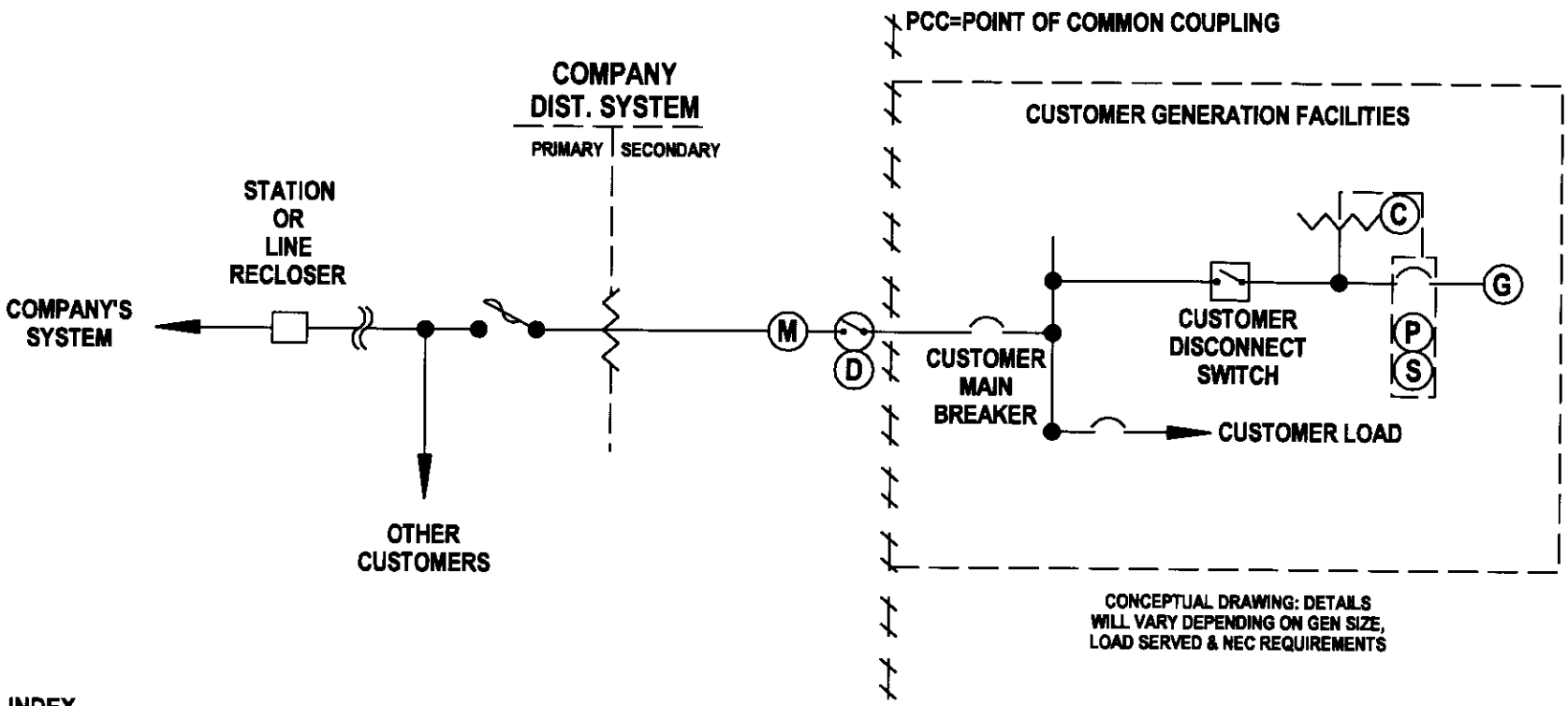
Authorized Signature: _____ Date: _____

Name (Print): _____ Title: _____

AEP AMERICAN ELECTRIC POWER

DISTRIBUTED ENERGY RESOURCE INTERCONNECTION TO AEP DISTRIBUTION SYSTEM

15KW AND BELOW (SINGLE PHASE)-RESIDENTIAL
25KW AND BELOW (SINGLE PHASE)-COMMERCIAL



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- Ⓜ CUSTOMER METERING FACILITIES
- Ⓢ SYNCHRONIZING CONTROL
- Ⓟ PROTECTION DEVICES (SPECIFIED IN CUSTOMER DESIGN REQUIREMENTS SECTION)
- Ⓓ SAFETY DISCONNECT SWITCH ACCESSIBLE TO COMPANY PERSONNEL AND LOCKABLE (INSTALLED BY CUSTOMER)
- Ⓒ POTENTIAL SENSING TRANSFORMER(S)

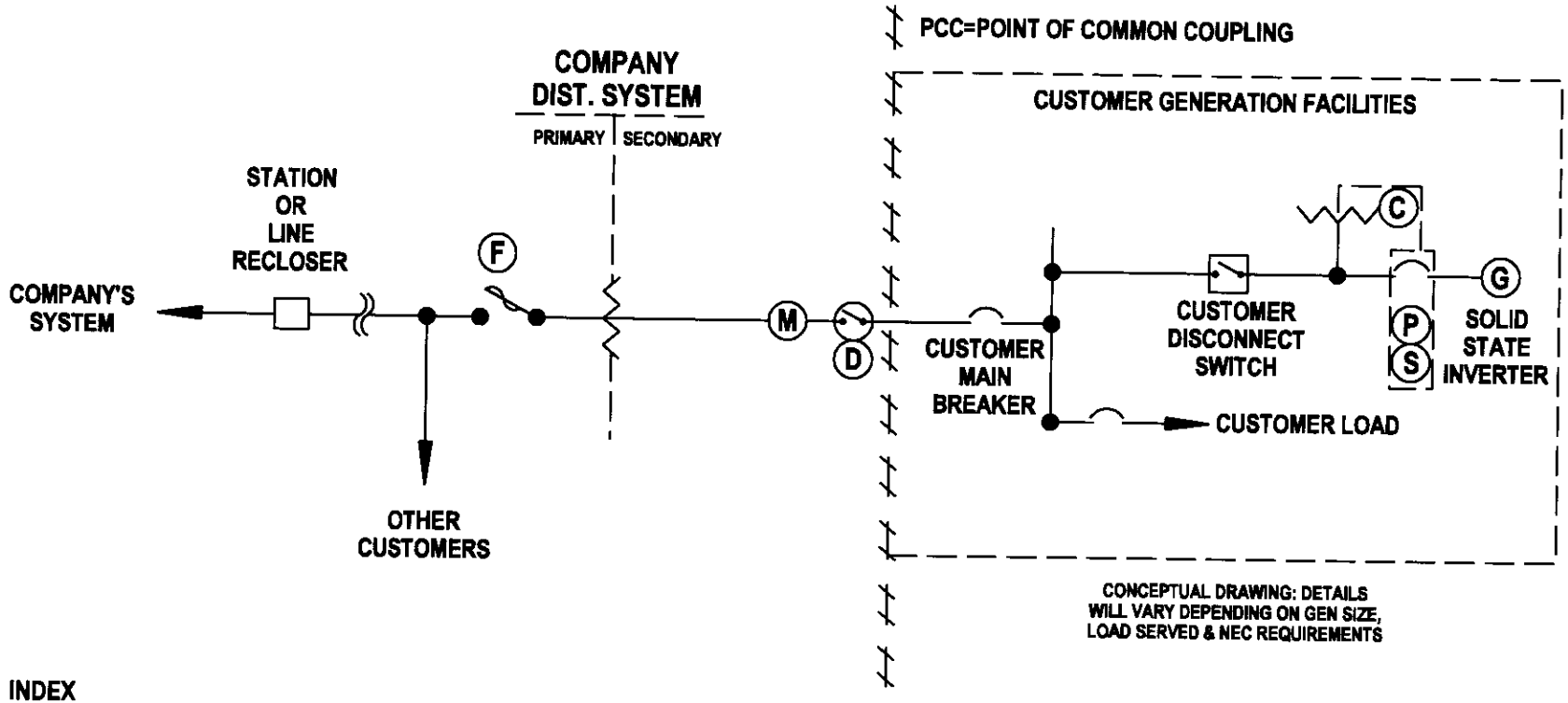
FIGURE 1 (PART A)

4/5/2000

AEP AMERICAN ELECTRIC POWER

DISTRIBUTED ENERGY RESOURCE INTERCONNECTION TO AEP DISTRIBUTION SYSTEM

THREE PHASE (INVERTER) APPLICATION



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- Ⓒ POTENTIAL SENSING TRANSFORMER(S)
- Ⓕ TRANSFORMER FUSE

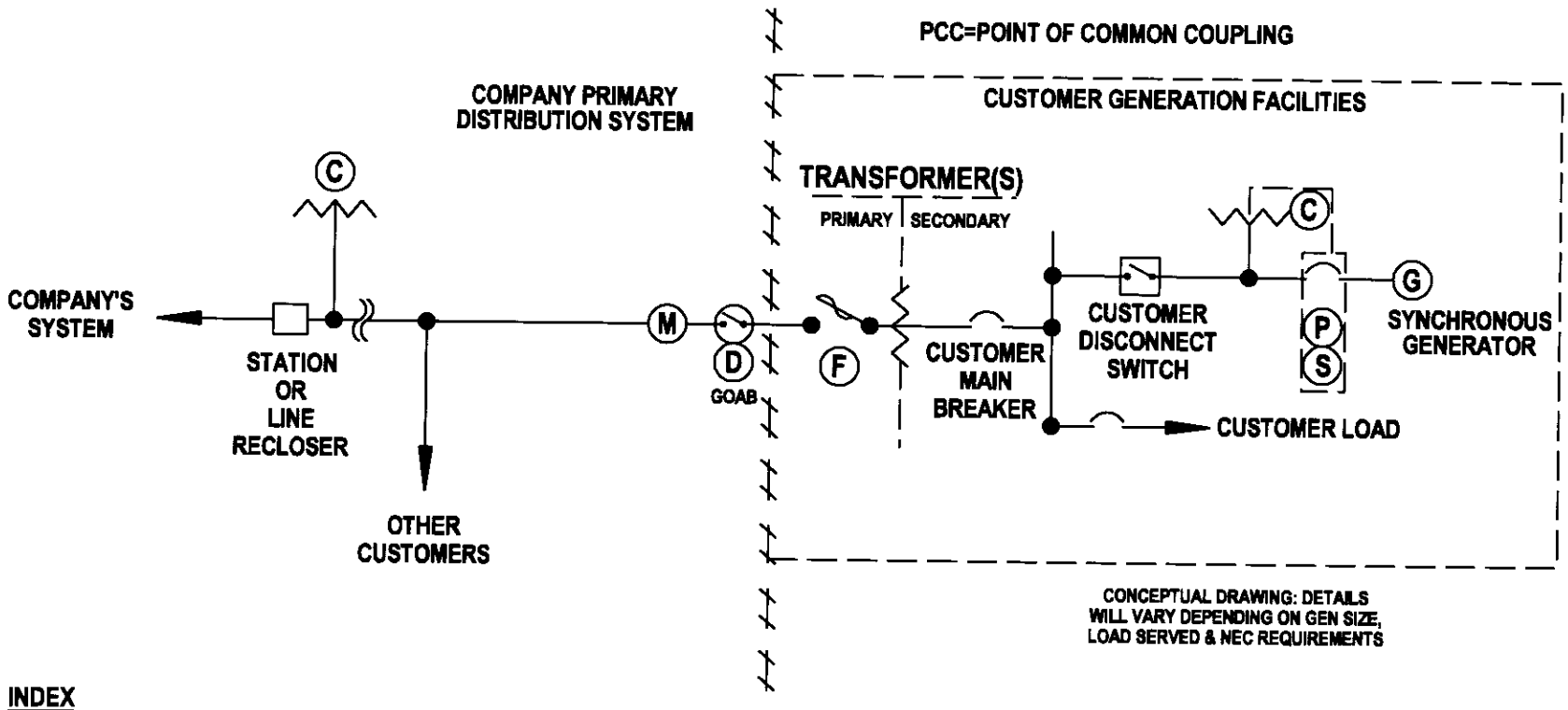
FIGURE 1 (PART B)

4/5/2000

AEP AMERICAN ELECTRIC POWER

DISTRIBUTED ENERGY RESOURCE INTERCONNECTION TO AEP DISTRIBUTION SYSTEM

THREE PHASE SYNCHRONOUS GENERATOR APPLICATION-PRIMARY METERED SERVICE



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- Ⓟ PROTECTION DEVICES (SPECIFIED IN SECTION 5.0-7.0)
- Ⓓ SAFETY DISCONNECT SWITCH (GOAB) ACCESSIBLE TO COMPANY PERSONNEL AND LOCKABLE (INSTALLED BY CUSTOMER)
- Ⓒ POTENTIAL SENSING TRANSFORMER(S)
- Ⓕ TRANSFORMER FUSE DISCONNECT

NOTE:
DEPENDING UPON GENERATOR SIZE, A TRANSFER TRIP SCHEME MAY BE REQUIRED ON THE TRANSMISSION AND/ OR DISTRIBUTION SIDE OF THE STATION.

FIGURE 2

4/5/2000

AEP AMERICAN ELECTRIC POWER

DISTRIBUTED ENERGY RESOURCE INTERCONNECTION TO AEP DISTRIBUTION SYSTEM

THREE PHASE SYNCHRONOUS GENERATOR APPLICATION-SECONDARY METERED SERVICE

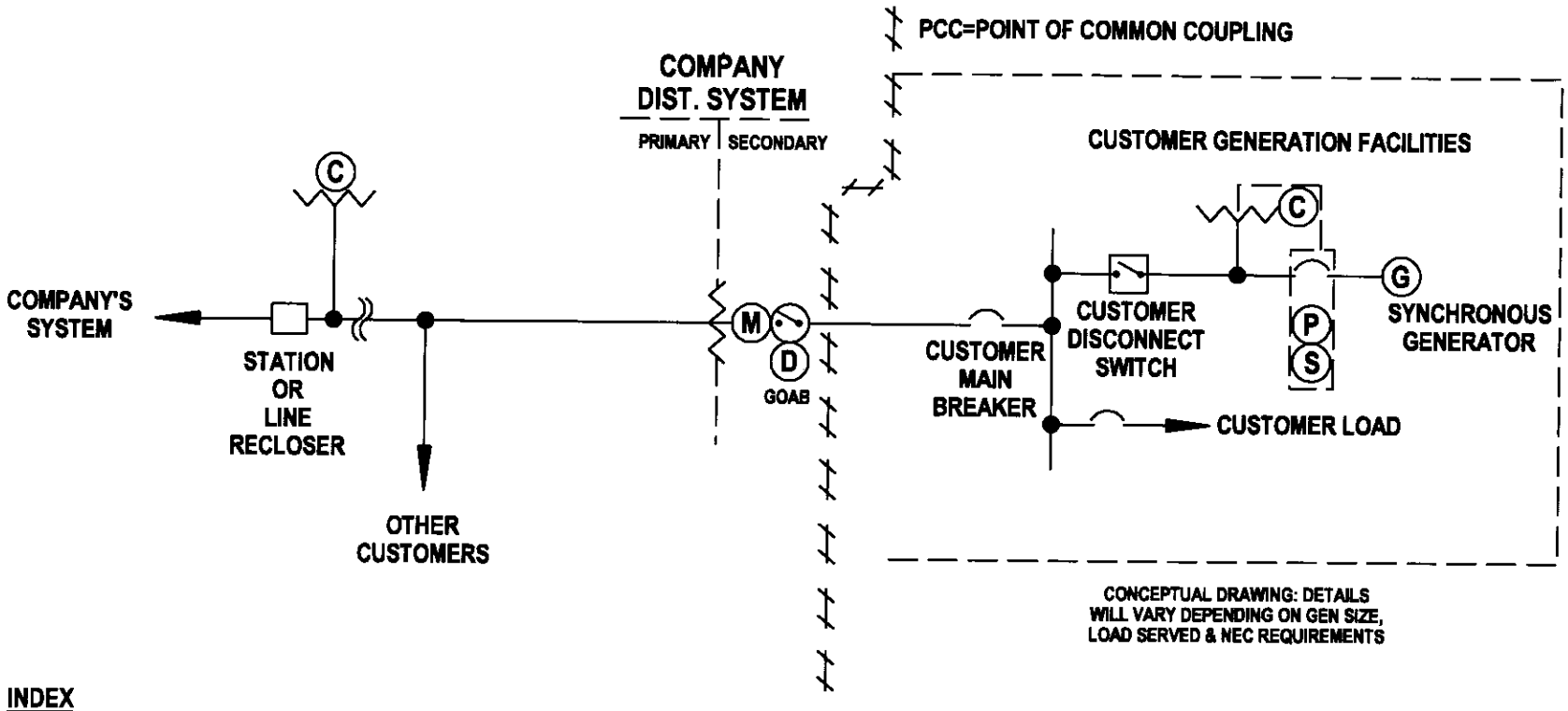

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FIGURE 3

4/5/2000

AEP AMERICAN ELECTRIC POWER

DISTRIBUTED ENERGY RESOURCE INTERCONNECTION TO AEP DISTRIBUTION SYSTEM

THREE PHASE INDUCTION GENERATOR APPLICATION-PRIMARY METERED SERVICE

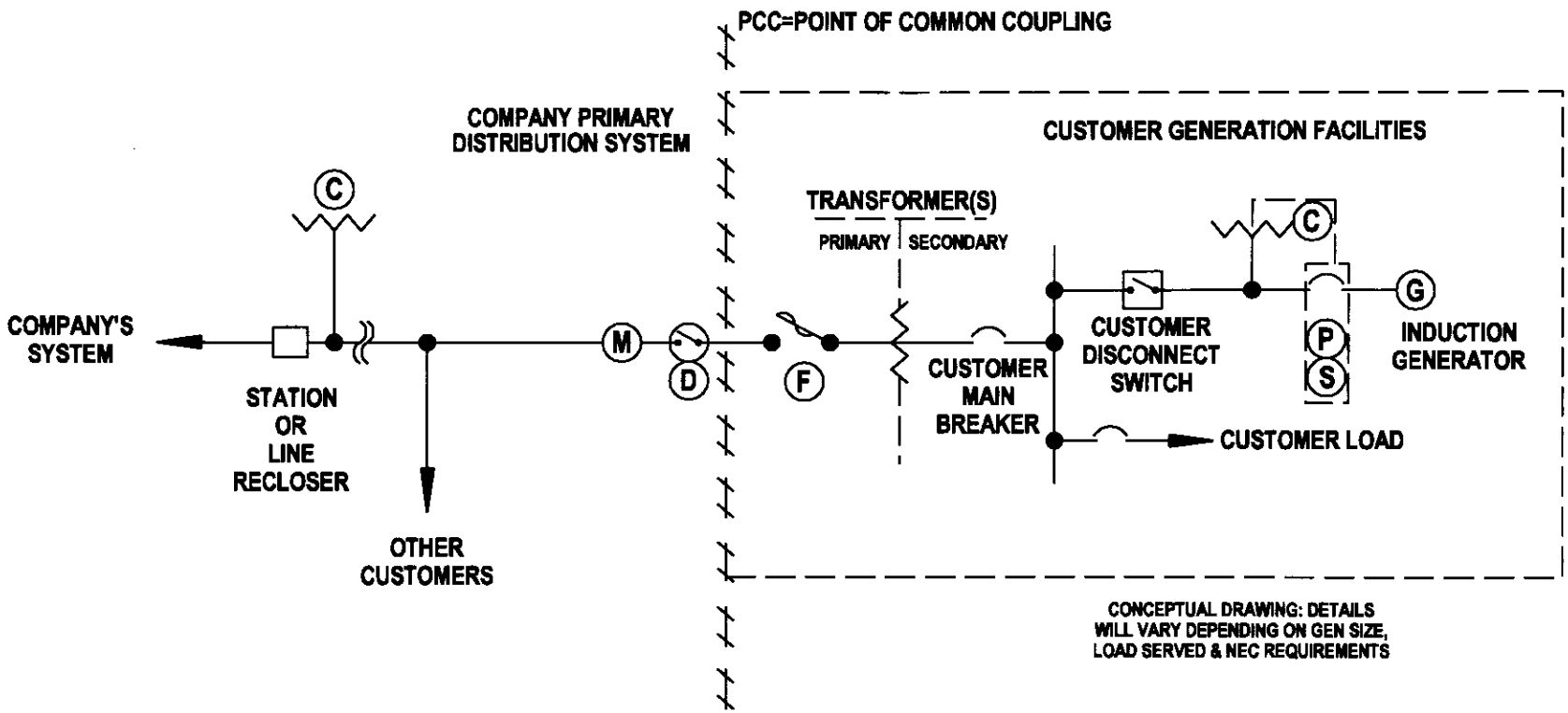

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FIGURE 4

4/5/2000

AEP AMERICAN ELECTRIC POWER

DISTRIBUTED ENERGY RESOURCE INTERCONNECTION TO AEP DISTRIBUTION SYSTEM

THREE PHASE INDUCTION GENERATOR APPLICATION-SECONDARY METERED SERVICE

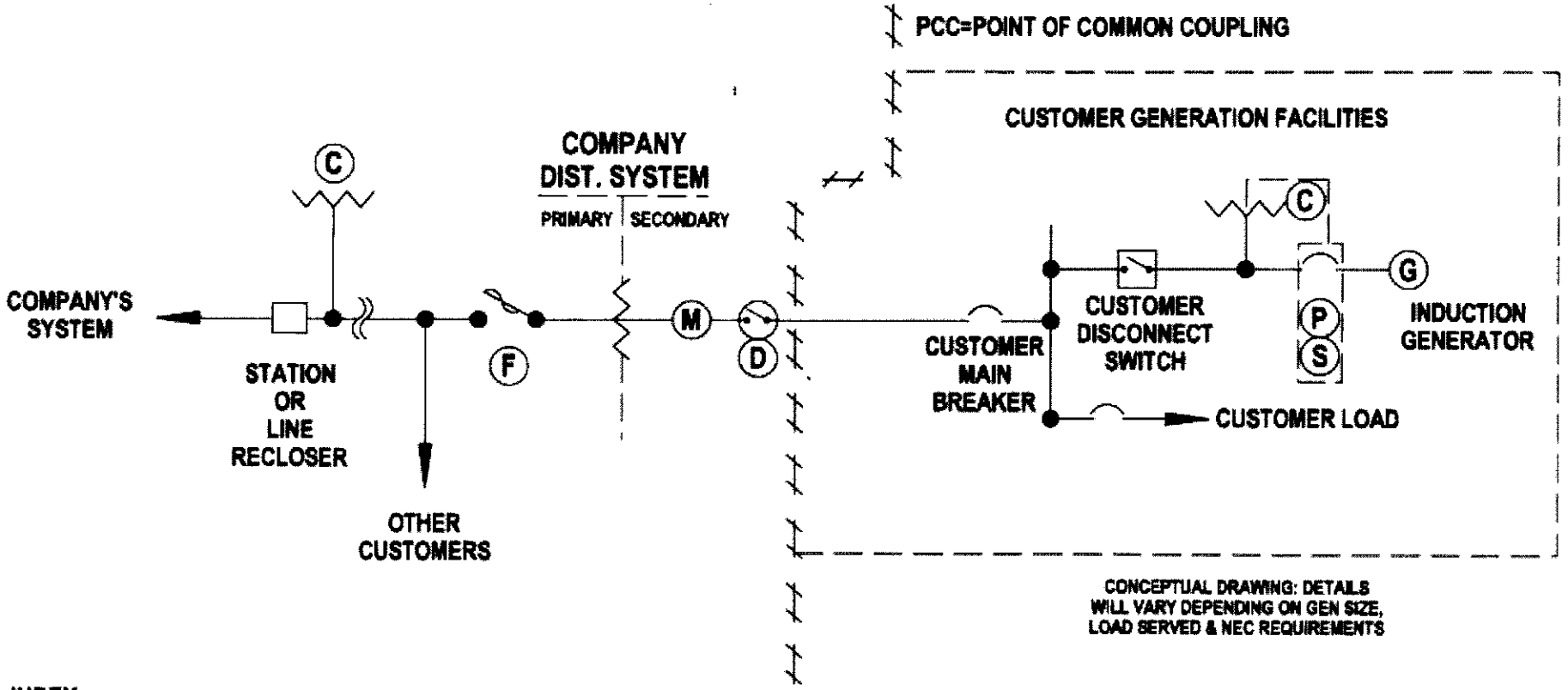

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FIGURE 5

4/5/2000